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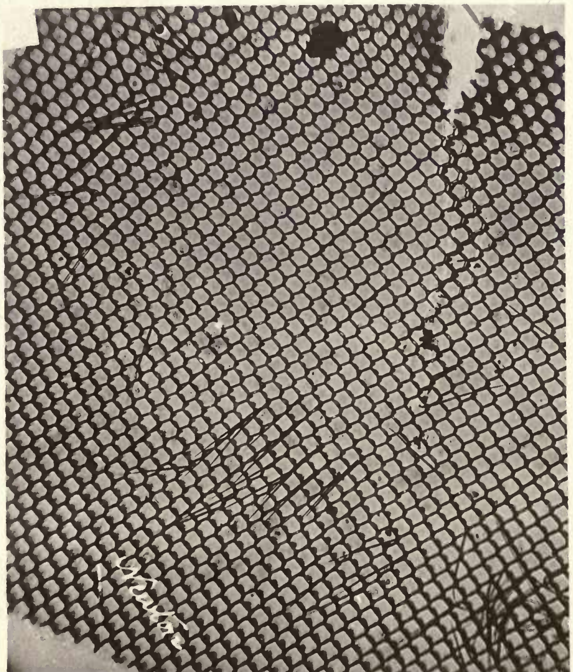
OUR HOUSEHOLD INSECTS

PLATE I.



PORTION OF CORNEA OF FLY'S COMPOUND EYE,

Showing about 1000 facets, and a few hairs growing from between them.

PORTION OF FLY'S FOOT,

Showing last four tarsal joints, terminal claws, and adhesive pads. Magnified about 50 diameters.

OUR HOUSEHOLD INSECTS

AN ACCOUNT OF THE INSECT-PESTS FOUND IN DWELLING-HOUSES

BY

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PREFACE.

THE contents of this book originally appeared as a series of articles in *Knowledge*, and I am indebted to the courtesy of the editor and proprietors of that journal for their re-issue in the present form. My aim has been to give a plain and easy account of such insect pests as may be met with in ordinary dwelling-houses, and thus to show that every one has ready to hand, with very little trouble in the way of collection, abundant material for the practical study of that most fascinating branch of natural history, entomology. As the book is written primarily for those who have no special knowledge of the subject, I have endeavoured to put the descriptions of insect structure into ordinary language as far as possible, and to abstain from the unnecessary introduction of technicalities. Where technical terms have been of necessity used, an attempt has been made to explain each on its first introduction. Though the book is intended primarily for the novice, I would yet venture to hope that it may be of some service to more advanced students of entomology, as bringing into one volume items of information that

at present exist scattered throughout the vast mass of entomological literature. The arrangement of the matter was necessarily determined to a great extent by the method of the original issue as a series of detached articles; had the work been written for publication in the present form, the plan would have been somewhat modified and made more systematic.

The seven page-plates have been made from photographic enlargements prepared for the oxy-hydrogen lantern by Messrs. F. Newton & Co. of No. 3 Fleet Street, London, who have kindly lent the negatives for the purpose.

E. A. B.

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OUR HOUSEHOLD INSECTS.

CHAPTER I.

WOOD-BORING BEETLES.

Man is accompanied in his migrations, not merely by what are familiarly known as the "domestic animals," but also by hosts of insects, which find improved means of subsistence by linking their fortunes with his, and which, though often causing him infinite annoyance, sometimes render considerable, though generally unrecognised and unappreciated services. In their persistent accompaniment of their lord and master, some have travelled over vast areas of land and sea, getting free passages in all the navies of the world; and we in this country owe several of our commonest insects to our commerce with foreign nations. It is "cupboard love" that impels insects to accompany man: they follow him for what they can get; his food they pilfer; his heirlooms they destroy; his house, his furniture, his clothes, they attack; and even his very person is not held sacred, especially if he himself so sins against nature as to violate the laws of cleanliness and health. So, not an abode can be found—whether of the most degraded barbarian on the one hand, or of the very cream of civilised society on the other—which can boast

of immunity from the intrusion of representatives of this immense horde of living creatures.

That some of this vast host should have special relations to mankind is not to be wondered at, when we remember that two of the chief functions of insect life in the world seem to be the repression of superabundant vegetation, and the removal of effete and waste matters; for while man in his agricultural capacity bids mother earth bring forth the "herb yielding seed after his kind" more and more abundantly, he often finds a serious check to his efforts in the mighty hosts of insects which the very success of his agricultural operations has been the means of vastly increasing; and, again, while in his constructive and manufacturing capacity he is busily engaged in converting natural products of the animal and vegetable worlds into things suitable for his own use, he thereby attracts the scavenger hosts, who, evidently regarding his accumulations of manufactured articles as so much lumber to be got rid of as quickly as may be, set to work on his cherished hoards with right good will, and tax all his ingenuity to save them from ruin. So it comes to pass that there are many species of insects that more or less permanently take up their abode with us, either actually in our houses and outbuildings, or in our cultivated lands, and depend in large degree upon us and our belongings for their support. It is only with the former of these groups that we propose to deal, but we shall find in them good representatives of insect life in general; and any one may obtain excellent material for the practical study of entomology and the examination of insect structure without going beyond the four walls of an ordinary dwelling-house.

As there are some animal pests found in houses

that are often called insects, though not really such, it will be best first of all briefly to indicate what kind of creature is implied zoologically by the term "insect."

Insects constitute a class of the animal kingdom distinguished from other invertebrate animals by having the body divided into three parts, head, thorax, and abdomen, and by possessing in the adult condition six legs disposed in three pairs, and usually four wings as well. The head carries first the mouth organs, which vary much in different groups, and will be particularly described hereafter, and secondly the organs of sense, consisting chiefly of the eyes and antennæ, the latter being that pair of long jointed appendages popularly known as "horns." The thorax carries the legs beneath and the wings above. The abdomen carries no legs in the adult insect, but has frequently in the females a more or less complicated apparatus at the end, sometimes looking like a long tail, and used for depositing the eggs, and therefore called an ovipositor. Most insects also pass through a series of transformations during the course of their life, which are called collectively "metamorphoses." They are first the egg; secondly the larva, grub, or caterpillar; thirdly the chrysalis or pupa; and fourthly the perfect insect or imago. There are other characteristics of a less obvious nature, but these are in most cases sufficient for practical purposes, and will enable one to determine what animals are insects and what are not. The class is subdivided, according to the nature of the wings, the feeding apparatus, and the life history, into groups called "orders;" and our household insects are so varied in structure that there is not a single important order unrepresented in domestic entomology.

We will turn our attention first to that order which is usually placed at the head of the class, viz., the Coleoptera, or Beetles.

Of these, a considerable variety make our houses their foraging quarters, and one of the most important sections is that of the "Wood-borers." These often commit great depredations in the beams and other woodwork used in the framework of houses, as well as in articles of furniture, producing the result known as "worm-eaten." Formerly, their ravages were more considerable than at the present day, owing to the then more extensive use of timber (and especially unpainted timber) in building construction. The external indications of the presence of these destructive insects are usually twofold: small circular perforations in the surface of the wood, and little heaps of yellow dust on the ground beneath them. The perforations are the entrances to, or rather exits from, long cylindrical tunnels traversing the wood in various directions, generally in that of its length, and often to so great an extent as to leave only the narrowest of partitions between them, and so reduce the whole interior to a mere network, which is so fragile as to crumble away on the slightest touch, while the outside still remains intact, except for the few perforations, and gives the wood the appearance of being almost as sound as when first put up. The beetles themselves are not so often seen, as they spend a large proportion of their life in their burrows. Their ravages are similar in result to those of the shipworm upon submerged timber, though the latter animal belongs to the Mollusca, and is a relative of such animals as the mussel, oyster, &c.

Several species of beetles are answerable for these damages; the commonest is a small cylindrical insect

called *Anobium domesticum* (Fig. 1). It is scarcely one-sixth of an inch long, of a dark brown colour, and, like most of its allies, has the head much sunk in the thorax, which is raised behind into a protuberance in such a way as to cause it to resemble a hood or cowl. When viewed sideways this has a most quaint appearance, and irresistibly reminds one of a coal-scuttle bonnet almost entirely enveloping the head. The upper pair of wings are in the form of hard horny pieces, quite useless for flight, and employed only to cover and protect the delicate membranous hind-wings. They are called elytra, or wing-covers, and it is from this peculiarity of structure that the order gets its name Coleoptera (sheath-wings). The wing-covers are marked with narrow, parallel, longitudinal furrows, and are covered with short soft hairs, termed collectively "pubescence;" under them are folded a pair of large-sized wings. The legs are of moderate length, but can be closely packed away under the body, when the insect looks like a mere cylindrical pellet of wood, earth, or other inorganic matter, or like a miniature cartridge fitting well into the tubular burrows. In this condition it may be rolled about without manifesting signs of life. The antennæ have the last three joints much larger and longer than the rest, a peculiarity which also pertains to other members of the family.

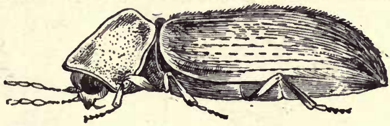


FIG. 1.—Anobium domesticum.

In its larval condition this insect is a thick fleshy grub, somewhat curved, and swollen at each end (Fig. 2). On the anterior part of the body it carries six tiny legs, a pair on each of the three segments immediately

succeeding the head. It is of a whitish colour, as might be expected in a creature which spends its time in the darkness of a tunnel; only in the jaws, and that part

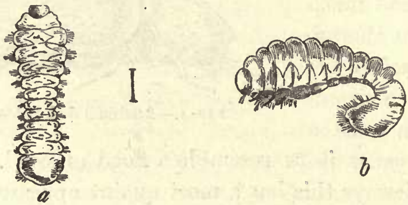


FIG. 2.—Larva of Anobium domesticum (*a*, back view; *b*, side view).

of the head immediately surrounding the mouth, is any more definite colour to be found, and this part appears as a dark brownish-black spot on the otherwise immaculate insect.

Except in the head, the skin is soft and yielding, and a few hairs are scattered along its sides. These larvæ are very seldom seen, as, in order to get at them, the wood in which they are domiciled must be pulled to pieces. Their food consists of the wood itself, which by their powerful though tiny jaws is bitten off in minute particles, many of which, however, are left uneaten, and either clog up the burrows or are ejected at their openings, where they constitute the tiny heaps of yellow dust referred to above. No wood is so old and dry that they cannot extract nourishment from it; in fact, the older and drier it is the better they like it. An animal subsisting on such food might be expected to be a lean wiry creature of half-starved aspect, but exactly the contrary is really the case; for these white grubs are fat and flourishing, and a full-grown one might be supposed to have been fattening up for a prize competition, for it looks as bloated as a prize pig.

They become a chrysalis in their burrows, enveloping themselves in a silken cocoon, in which are interwoven particles of the dust they make. On emerging from the chrysalis they remain inactive for some time, not coming out of their burrows, and only gradually acquiring their normal colour and consistency, and with these their activity.

An insect allied to *Anobium domesticum*, and formerly referred to the same genus, but now known as *Xestobium tessellatum*, has often been a source of terror to the superstitious, by whom it is known as the Death Watch. It is a stout reddish-brown beetle, sprinkled with small patches of pale hairs; but, while very similar in shape, it is a great deal larger than any of the *Anobia* proper, sometimes attaining a length of one-third inch, and a corresponding obesity (Fig. 3).

FIG. 3.—Xestobium tessellatum.

The ticking or clicking noise that is sometimes heard in old houses, and has so often been considered to portend the death of some inhabitant of the dwelling within the year, is caused by these insects striking the wooden walls of their burrows with their hard heads or jaws, and is generally supposed to be a love-call, for when one has made some four or five taps in quick succession, it pauses, and is immediately answered by another in some different quarter. The tapping is not sufficiently loud to attract much attention in the daytime, when so many other noises are going on; but in the stillness of the night, when every sound that does occur seems magnified to an enormous degree, this regular succession of knocks, proceeding from no apparent

physical cause, might, on the principle of *omne ignotum pro mirifico*, easily awake apprehension in the minds of the ignorant and superstitious, already by habit accustomed to look out for "omens," "visitations," "warnings," and the like; and it is, perhaps, not altogether to be wondered at that amongst those engaged in nursing the sick, who, from the stillness of the sick-room, and the fact of their being night-watchers, would generally be the most likely to meet with such experiences, some should have seen in these mysterious tappings a confirmation of their own anxious forebodings with respect to the loved ones of their charge. But the application of a little practical common-sense soon dispels these illusions, and demonstrates the very material nature of the omens, or, as Swift quaintly puts it:—

> "A kettle of scalding hot water ejected
> Infallibly cures the timber affected;
> The omen is broken, the danger is over,
> The maggot will die, and the sick will recover."

In the "Philosophical Transactions" for 1698 is a curious paper entitled "An Account of the *Scarabæus Galeatus Pulsator*, or the Death Watch, taken August, 1695, by Mr. Benjamin Allen." It is accompanied by an enormously magnified figure of the insect, and from this and the description, it is evident that the Scarabæus is none other than our present acquaintance; and the article appears to be the earliest detailed scientific account of the insect. The writer commences in a somewhat spasmodic and inconsequent style:—"The second Animal I observ'd is a Death Watch: I have taken some before this, it is that which makes a noise resembling exactly that of a Watch; it is faithfully the very same, and liv'd Four Days with me, beating exactly, for

I took two, I suppose one was the Female, that is only conjecture." He is a little bit sceptical as to the prophetic character of the tappings, saying, "This small Beetle . . . being rarely heard, and not known, has obtain'd the name of a Death Watch, which yet I have known to be heard by many, when no mortality followed, and particularly by myself, who have taken Two of the same, Seven years since, without any Death following that Year." A quarter of a century later, another observer, Mr. Hugh Stackhouse, communicates a further note on the subject, wisely abstaining, however, from any reference to the theory of prognostications. He prefaces the article by an account, almost needlessly minute and circumstantial, of the way in which he gradually tracked the insect by its ticking, till he found it in the seat of a rush-bottomed chair. Here he watched the little creature at work, and was so delighted with his discovery that he "called up others to see it beat, which they did, not without admiration." He then proceeds to describe the "manner of its beating." In its helmet-like thorax—or galea, as he calls it—he sees "a very notable and providential defence against such falls as are frequent in rotten and decayed places." He transferred his captive to a box, and kept it alive about a fortnight, but was unable to get it to beat again during its captivity, apparently through not knowing how to induce the action, for in the *Entomologist's Monthly Magazine* for 1866, the late Mr. F. Smith states that he had no difficulty in getting some that he kept to tick whenever he wished, by simply tapping five or six times with a lead pencil upon the table close to the box in which they were confined. They very shortly answered the summons. Raising themselves on their front legs, they commenced bobbing their heads up and down,

rapidly tapping with their jaws on the bottom of the box. The number of taps on each occasion was either four or five, usually the latter.

The Dutch naturalist Swammerdam, who flourished during the latter half of the seventeenth century, speaks, in his "Book of Nature," of an insect, no doubt either the present or an allied species, which "makes a continual noise in old pieces of wood, walls, and ceilings, which is sometimes so loud that, upon hearing it, people have been persuaded that nocturnal hobgoblins, ghosts, or fairies wandered about them." He adds, "I think this may be properly called Sonicephalus, or Noisy-headed Beetle."

A totally different insect, known generally as the "book-louse," has also been credited with being the producer of Death Watch tappings. It is an extremely minute, soft-bodied creature, belonging to the order Neuroptera, and is a very common inhabitant of houses. But it does not seem possible that a creature of such delicate structure should create these noises; however, we will recur to this subject when, later on, we come to the consideration of the insect in question.

Xestobium tessellatum, being so much larger than the Anobia, is, of course, far more destructive to timber, if allowed to have full scope for its powers. Spence speaks of the whole of the woodwork of a house in Brussels requiring to be renewed in consequence of its depredations, and states that he was informed that this was no uncommon occurrence there, the inhabitants calmly acquiescing in the attacks of their tiny foe, through ignorance of any plan of exterminating it, or at any rate checking its ravages. Like most wood-feeders, it is long-lived in the larval state. Westwood kept one for three years before it attained its perfect form.

Though *Xestobium tessellatum* is the principal beetle which, in this country, has been identified with Death Watch tickings, it is not alone in this claim to the character of harbinger of death. *Anobium domesticum* also ticks, and has, no doubt, scared many a rustic equally with *Xestobium*. One entomologist at least—the indefatigable Professor Westwood—once kept a regular diary of its tickings, the particular specimens whose doings were chronicled being inhabitants of a wooden mantel in the Professor's study. They ticked at intervals during the winter months, as well as at other seasons, though at such times the noises could scarcely have been intended, as they probably are during the warmer months, as an exchange of compliments between love-sick couples.

Notwithstanding the obscurity and retirement of their life, these wood-boring beetles have not managed to escape the attacks of parasites. Several species of ichneumon flies and other allied insects prey upon them; and the delicate little gauzy-winged persecutors may sometimes be seen running about hither and thither over Anobium-infested wood, in maternal anxiety to find a suitable *nidus* for their brood. Some, too large to enter the burrows, are furnished with a long ovipositor with which to reach their victims, into whose bodies they insert their eggs. Others are small enough to enter the burrows bodily, and hunt their prey like a ferret after a rabbit. One of these latter, *Theocolax formiciformis*, superficially something like a minute ant, in consequence of the absence of wings, I have obtained in .considerable numbers from a colony of *Anobium domesticum* which had established themselves in an old aquarium stand.

Yet another member of this family of wood-borers,

of very similar appearance to *Anobium*, sometimes does considerable damage to woodwork. It is especially partial to willow-wood, in which it makes neat cylindrical burrows. It is called *Ptilinus pectinicornis*, and the specific name refers to a remarkable peculiarity in the antennæ of the male, the sex which, for a reason that will appear presently, is most commonly seen. It may be recognised by its extremely cylindrical reddish-brown body and rather swollen black thorax (Fig. 4). The antennæ are marvellously beautiful. Instead of being composed of a mere string of simple joints, such as constitute those of the allied species, and, in fact, of beetles in general, they appear, when fully spread out, like two pieces of deep fringe. This results from each joint, except the two at the base and the one at the apex, carrying a lateral appendage generally far longer than itself. The apical joint is itself of the same form as these appendages, so that altogether there are nine of them; but the one nearest the base is much shorter than the rest, and seems little more than like a stout tooth; while the last seven, which are of nearly equal length, are several times as long as the joints to which they belong. Antennæ of a similar character occur in a few other British beetles, though in none is the peculiarity so greatly exaggerated as in the present species.

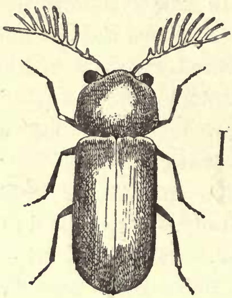


FIG. 4.—Ptilinus pectinicornis (male).

It is not easy to conjecture the *raison d'être* of this remarkable feature, for there seems to be little in the habits of the insect to account for its differing from its

congeners in so peculiar a way. It can scarcely be merely a sexual distinction, but seems to point to some greater acuteness in the organs of sense, perhaps necessitated by the fact that the female rarely leaves her burrows, only advancing to the entrance thereof to receive the addresses of her lord and master, who, on his part, remains on the outside, and conducts his courtship from that position. It is a curious fact that the males of certain moths, which have similarly complex antennæ, possess also a marvellous power, quite independent of sight, of detecting, even from great distances, the presence of a virgin female of their own species.

Ptilinus is sometimes terribly destructive to timber; and apparently the most remarkable instance on record of this undesirable characteristic is one given by Westwood, who states that a perfectly new bed-post (those were the days of the great four-posters that lumbered up our fathers' bed-chambers) was, in the space of three years, completely destroyed by countless numbers of these insects. But such depredations are necessarily becoming more and more things of the past, and in these days of iron bedsteads, &c., *Ptilinus*, and others of that ilk, must be beginning to find that they have fallen on evil times, and that the conditions of life are not nearly so favourable as they used to be in the happy days of old. I have found it also in a printing-office, where, in the abundance of wooden "plant" stored up, it must have discovered a perfect mine of wealth.

Anobium domesticum is not the only representative of *that* genus in our household fauna; another is *A. paniceum*, a shorter and broader insect of somewhat paler colour. It is almost omnivorous in its tastes, attacking any sort of vegetable substance that may fall in its way, though less of a wood-borer than its relative. Such things

as dry bread, biscuits, rhubarb root, ginger, wafers, and even so unlikely a substance as Cayenne pepper, have been greedily devoured by it; and it has also not unfrequently attacked ships' biscuits, riddling them through and through, and damaging them to such an extent as to render them quite unfit for human food. Nor does it make any difference if the vegetable matter is not in its primitive condition, but has had its character so much altered as is involved in having passed several times through the hands of the manufacturer: thus, paper will furnish it with an enjoyable meal, and books even yield it *physical* sustenance. A curious case of the latter is recorded of either this insect or some closely allied species: twenty-seven folio volumes in a public library were perforated in a straight line by one and the same insect, and so regular was the tunnel that a string could be passed through the whole length of it, and the entire set of books lifted up at once thereby—a tolerably clear proof that the library, or, at any rate, that particular portion of it, could not have been in great request with *human* bookworms, or the *insect* ditto would scarcely have found its course so entirely unimpeded.

Drawings and even paintings have also been destroyed by this insect, and on one occasion it invaded the sacred seats of learning and made away with some Arabic manuscripts in a library at Cambridge, and at another time wrought havoc in the herbarium of a botanist. The powerful jaws of the larva, too, are not deterred even by a thin coating of metal, for Westwood records having seen tinfoil perforated by it, no doubt for the purpose of pilfering some treasure contained beneath.

So, while *A. domesticum* destroys chairs, tables, picture-frames, cupboards, floors, &c., and sometimes

terrifies nervous old ladies by its ticking, its relative *A. paniceum* attacks the stores of comestibles, works of art, and literature of the dwelling, and between them they would, in the course of time, if unchecked, produce terrible ruin.

When found in woodwork out of doors, the direct damage insects of this kind do by the actual excavation and devouring of the wood is not the only injury for which they are responsible; for damp air enters the substance of the wood through the burrows, and meeting with the excrement, which is stored in great quantities in the burrows, renders it a good basis for the growth of microscopic fungi, whereby the decay of the wood is accelerated.

All the insects hitherto enumerated belong to the family *Ptinidæ*, of which they constitute one section, the *Anobiides*, distinguished, at least so far as our house-feeders are concerned, by their more cylindrical form, compact make, and shorter legs. In the other section, the *Ptinides*, to which we now turn our attention, the shape is more globose, the antennæ and legs much longer, and the thighs so much thickened at the outer extremities as to become club-like. From their shape it would be easy to conjecture what would be in accordance with facts, that they have less to do with cylindrical burrows than their companions who "swear by" *Anobium*.

The typical genus of the Ptinides is *Ptinus*, and the commonest species of that genus *P. fur* (Fig. 5). This is also a household insect, and is of somewhat varied habits. It well exemplifies a peculiarity exhibited with more or less distinctness in several species of this genus, viz., dissimilarity in shape between the sexes: the body of the male is almost cylindrical, but that of the female inflated

or rounded at the sides, a feature which so alters her appearance that a novice would be certain to divorce her

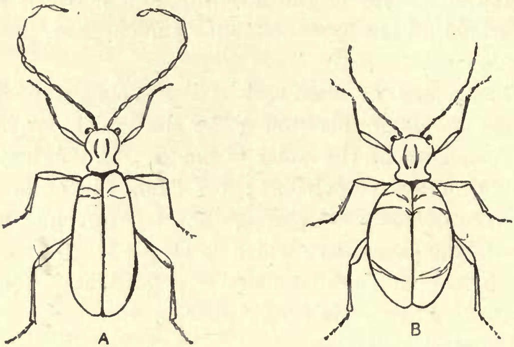


FIG. 5.—Ptinus fur (A, male ; B, female).

from her husband, and consider her a distinct species. It is a reddish-brown, hard insect, with two narrow and somewhat indistinct bands of white hairs on the elytra ; the head is so much bent under the thorax that it cannot be seen from above, so that the insect appears as though it had been decapitated. The legs are long and straggling, notwithstanding which the creature is slow and heavy in its movements. The thorax is a good deal contracted behind, appearing as though it had been tied round tight while soft, and had hardened in that condition. By attending to these few points of distinction, there can scarcely be much difficulty in recognising a *Ptinus.*

This insect is a great foe to Natural History collections, whether of animals or plants : and if by any chance it can manage to effect a surreptitious entrance into such, it does its best to execute the sentence " dust to dust " upon them. But its tastes are varied, and range from such excellent diet as the precious grain stored in granaries to the apparently less attractive nutriment

furnished by the threadbare fabric of an old coat, the vegetable and the animal diet seeming equally suited to its taste, though it was at one time considered to be so largely an animal feeder as to have been called by De Geer *vrillette carnassière*, "the carnivorous borer."

Those who keep collections of foreign insects may sometimes have the privilege (?) of breeding (unintentionally) exotic species of *Ptinus*. Dried insects, when arriving from abroad, sometimes contain in their carcases living larvæ of *Ptinidæ*, which fare sumptuously, though silently and unobserved, upon the "dried meat" by which they are surrounded—a veritable "life in death." I remember on one occasion looking at a store box of exotic insects that had not been opened for some time, and being astonished at finding a colony of some dozen or so of a beautiful bright red *Ptinus*, prettily ornamented with snow-white spots, gaily disporting themselves amongst my stores, quite regardless of such insecticides as were present. I succeeded in tracing them to the huge carcase of a gigantic beetle that I had unfortunately introduced into the society without previously submitting to quarantine, and in whose interior the larvæ had evidently been holding carnival at the time of his introduction.

The *Ptini* turned out to be a Polynesian species, which had thus completed their life cycle many thousands of miles from their birthplace. On their exclusion from their coleopterous host, they seemed to have decided on a change of diet, and so had calmly attacked the cork lining of the box, neatly excavating in it a series of hollows, to the extreme detriment of its appearance, at least from my point of view.

A most extraordinary trio of beetles now calls for notice. They are closely allied to the genus *Ptinus*,

to

and belong to the same section of the family. They have very much the appearance of spiders, for which, indeed, they are often mistaken. The first is *Niptus hololeucus* (Fig. 6). It is a small beetle, completely covered with a yellowish silky down, and its resemblance to a spider is produced by three peculiarities. A spider, which, be it remembered, is not an insect at all, but a member of the class Arachnida, has only two apparent divisions to its body, the hindermost of which is usually highly convex and rounded at the sides, and it has also eight legs. Now, though *Niptus* has distinctly the usual *three* divisions of an insect's body—head, thorax, and abdomen—the first of these is so bent under the second that, as in *Ptinus*, it cannot be seen from above; and, in consequence, the body seems, like that of a spider, to be composed of only two parts. The elytra are very convex above, and much inflated and rounded at the sides, and as the line of their junction is completely obliterated, the abdomen acquires the globose and undivided form of that of a spider. Again, the antennæ, which are about equal in length to the legs, and, of course, on account of the bending of the head, appear to come from underneath as much as the legs themselves do, make up, with the usual six legs, a number of appendages that may readily be taken for the eight legs of a spider. The imitation is so complete, that, when only casually seen, the beetle might easily deceive even those who are perfectly familiar with the difference between an insect and a spider. When once one examines

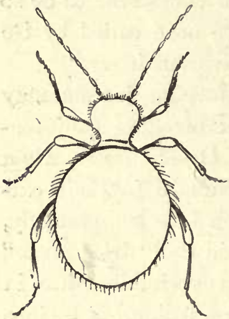


FIG. 6.—Niptus hololeucus.

it closely, however, the apparent resemblances vanish, and the creature is easily seen to be a true insect, and is moreover found to be as hard-bodied as a *Ptinus*, instead of exhibiting the soft and yielding integument of a spider.

It occurs commonly in houses, often in considerable numbers. It is not a wood-borer, but feeds on anything it can come across that is at all edible, and, in consequence, most frequents cupboards where stores of provisions are kept. It was once found in great numbers in a plate-cupboard, where it was *said*, though with what degree of justice it is very difficult to understand, to have done considerable damage to the silver stored there. It has no wings, and is therefore not much of a wanderer, so that when a colony has once established itself in any part of a house, the successive generations are likely to remain in those quarters as long as provisions last, unless forcibly ejected. It is probably not a truly indigenous insect, but, like many others, has been imported from abroad, so that, although not blessed with great powers of locomotion, it has yet been a considerable traveller.

Under the microscope, the yellow clothing of *Niptus* is seen to be composed of two totally distinct elements. There are a number of longitudinal rows of long hairs or bristles, projecting considerably above the general surface, and pointing backwards; and beneath these, closely covering the body, a quantity of tiny yellow scales, overlapping one another. Each scale is bluntly pointed at the place of its attachment to the body, and at the outer extremity is usually produced into two long pointed projections at the sides, with a shorter one between them (Fig. 7). Not unfrequently the central process is also cleft. When the scales are removed, the

body beneath is seen to be highly polished, and of a deep chestnut colour.

To return to our spider-like trio: the first we have

FIG. 7.—Scales of Niptus.

FIG. 8.—Mezium affine.

already considered; the second, *Mezium affine* (Fig. 8), is even more spider-like than its predecessor. Unlike *Niptus*, however, it is clothed with hairs only on the head and thorax. Its elytra are perfectly bare, of a chestnut-brown colour, brilliantly shining, and extremely globular, very much like what those of *Niptus* would be if denuded of their scales. The head and thorax are covered with yellowish-white hairs, so thickly disposed that one might imagine the creature was of an asthmatic temperament, and so needed to protect itself by wrapping its upper regions in a great woollen muffler or comforter.

This is not nearly so common an insect as the last, but it is equally varied in its tastes. An old opera-hat, which had been laid aside for some time, once nourished a considerable colony; and it has also been found inside the carcase of another beetle, the greater part of whose contents its larva had devoured. The creature had passed through the whole of its changes in these contracted quarters, the larva having formed there a silken cocoon intermixed with particles of its own excrement.

The third member of our little party is *Gibbium scotias* (the hump-backed lover of darkness) (Fig. 9). It is much

like *Mezium*, but more stumpy, and entirely destitute of hairs, except on its antennæ and legs. It looks more like a great mite than a spider, and from its colour and rotundity has been fancifully compared, especially when tucking its legs under its body, to a drop of blood.

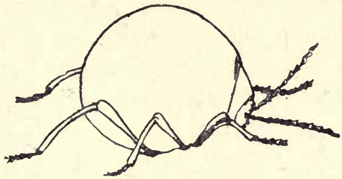


FIG. 9.—Gibbium scotias.

At Newcastle this insect has been found in some numbers in a dry cupboard, where, it would seem, they had obtained a comfortable living from the wall-paper and the dried remains of the paste with which it had been hung. This latter is a very favourite repast with several small insects that are pests in Natural History collections; it is well, therefore, to take the precaution to mix a little corrosive sublimate with the paste used in preparing the mounting-boards for zoological specimens, that by being thus poisoned, it may become safe from the attacks of the tiny depredators.

Gibbium has also been found amongst old hay, and on one occasion a heap of their carcases was discovered amongst a resinous substance in a vase obtained from a mummy at Thebes, but whether they were an original embalmment or a subsequent invasion was not very clear.

CHAPTER II.

CLUB-HORN BEETLES.

WE now turn to another family of beetles, the *Dermestidæ*, a group of small extent, but of most destructive habits. One of them has rendered itself sufficiently obnoxious to have acquired a popular name, the "Bacon Beetle," a designation which indicates not a necessary association, but merely a casual one, which, however, has, more than any other, brought the insect under the notice and reprobation of human kind. In scientific language it is still called by the name under which the great Linné wrote of it in his "Systema Naturæ," viz., *Dermestes lardarius*, the second word of which is an almost literal translation of the popular name. The generic title *Dermestes* is from the Greek *derma*, a skin, and indicates that the tastes of the insect lie, not only in the direction of fat bacon, but equally in that of tough leather.

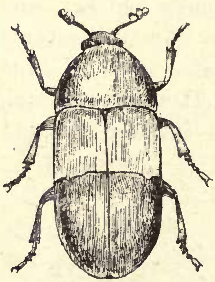


FIG. 10.—Dermestes lardarius.

It is a parallel-sided convex rather elongate insect, about one-fourth inch long (Fig. 10), and may be at once recognised by the yellowish-grey band which sweeps right across the elytra, occupying almost the whole of

their basal half (*i.e.*, the part next the thorax), in sharp contrast to the black of the remainder of the body, both before and behind. The two colours meet abruptly in a well-defined, somewhat wavy boundary line, running across from side to side. In the present order it very frequently happens that, as we have already seen in *Niptus*, the colours that appear on the surface are not ingrained into the skin of the insect itself, but are produced by hairs or scales, with which it is more or less thickly coated; and it is not until these have been removed that the true colours of the body, which do not necessarily correspond with the superficial ornamentation, can be clearly ascertained. The present insect is covered tolerably thickly with hairs, and the parts that are superficially black are also of that colour when denuded of their covering, but under the pale patch the elytra are of a very deep reddish-brown.

The head is of small dimensions, and, when the insect is at rest, is carried bent down beneath the thorax, a position from which, in a defunct individual, the coleopterist who desires all parts of his specimens to be properly displayed, finds it no easy matter to coax it out. The antennæ are of the type known as clubbed, a feature which indicates that the insect belongs to that large section of the beetle order called Clavicornia, or Club-horns, a group containing about 600 British species, a good many of which are feeders upon carrion and the dried carcases of other animals.

A clubbed antenna is usually almost abnormally short, and may be at once distinguished by the fact that the terminal joints, two, three, four, or five in number, are much broader than the rest. It is surprising how many varieties this very simple peculiarity is capable of, and these variations are of much importance in the

systematic arrangement of the insects. In our present species the club consists of three flattened joints, broadened inwardly only, whereby it acquires a one-sided appearance.

The legs are of moderate length, and are packed up under the body when their owner counterfeits death, as it very readily does on the slightest alarm, being, as well becomes so inveterate a pilferer, of timid and retiring habits. But this folding up is not so perfectly carried out as in many other insects, for the last section of the limbs, viz., the five-jointed tarsus, or foot, is not folded back upon the preceding part, or tibia, but simply brought up so as to make an angle with them.

The larva of *Dermestes* is something like a very hairy caterpillar, and is no connection of those lively maggots that also infest bacon, and whose acrobatic feats have earned for them the name of "jumpers." It casts its skin several times in the course of its life, and on account of the multitude of hairs (which are shed with the skin and renewed each time), the rejected vestment does not shrivel up, but retains the form of the larva, a very substantial ghost of its former self.

We possess five British species of this genus, all of which are essentially devourers of skins and dried carcases; in fact, they are the jackals of the flesh flies, coming round when the maggots of the latter have finished up all the soft and juicy parts of a fresh carcase, and clearing off the hard and dry remnants of the skin, tendons, ligaments, &c., which their predecessors have left untouched. This is their natural function in the economy of nature, and when man also accumulates stores of dried meats, skins, feathers, horns, and hoofs, it is not to be wondered at that they forsake the scanty and precarious provisions of dame Nature, and invade

his precincts who has so thoughtfully laid up such grand stores for them.

Some years ago, *D. vulpinus*, a black species with a white patch on each side of the thorax, swarmed to such a degree and was so destructive in large skin warehouses in London as to bring forth the handsome offer of £20,000 for an available remedy. But satisfactory remedies against the ravages of insects are usually difficult to discover, and difficult also to apply; and it is not altogether surprising that even so tempting an offer failed to secure the desired result. The curators of museums, too, are likely to have their peace of mind affected by the ravages of *Dermestes.* The larvæ are by no means particular as to the class to which a preserved animal belongs, and so birds, beasts, and fishes, crabs, insects, and spiders may any or all fall before their jaws. Sometimes they will attack a skin by nibbling away at the roots of the hair or feathers, and so make a nice clean shave of the whole affair; occasionally they will forsake an animal for a vegetable diet. Cork is a substance much favoured with their attentions, and an account has been placed on record of the destruction of a whole ship's cargo of this material by vast numbers of them. On another occasion they actually abandoned some tempting skins on which they had been feasting for a set of corks that had been introduced into their quarters. Nor is the housewife exempt from anxiety on the score of *Dermestes.* Not only flitches of bacon, but even the meat in larders, and the bladders covering the tops of jam-pots, have on occasions yielded to their rapacity; books and papers, too, are not safe, and, strangest of all, they have sometimes actually imitated the example of *Anobium*, and bored into wood, feeding on the timber as they advanced.

But the most repulsive charge against them is that of anthropophagy. Some years ago, some Egyptian mummies were discovered, which, perhaps through straitened circumstances in the family to which they belonged, or through the shiftiness of some dishonest firm of embalmers, had evidently been prepared with less care than was usually expended on such objects. On being unswathed, the bodies were found to be pierced in some places by an insect identical with the London warehouse pest above referred to, viz., *D. vulpinus*, some examples of which had worked their way through two or three folds of the mummy-cloth and there perished. The bodies, on being opened, were found to contain thousands of the larvæ, together with many more of the perfect beetles—of course, all mummified and saved from decay by the same drugs as had preserved the mummy itself. From the facts that death had overtaken the larvæ in the fulness of their powers, that only a few beetles had escaped from the body, and that these had not been able to work their way out completely, it is manifest that they must have commenced their attacks during the preliminary processes of embalmment, when evidently the body had been somewhat neglected, and that most of them had been killed by the later stages of the operation, a few only surviving its completion, and they were without strength sufficient to eat their way completely through the investing mass into daylight.

The *Dermestes* were accompanied by another beetle, a bright blue species called *Corynetes violaceus*, which also is a common British insect, and a devourer of carrion and skins, though belonging to a different family. It was well for the feelings of the survivors and owners of the precious relics that all these insects perished where and when they did; for think what a shock it would

have given to the family to see a host of beetles come trooping out of the corpse of their respected relative, the integrity of whose remains had been an object of their pious care! In consequence of the great amount of preservatives used, the bodies themselves, when once properly prepared, would probably be exempt from insect attack, but not so the wooden cases in which they reposed, which could easily be, and were, perforated by wood-borers such as *Anobium;* and, to judge from some in the British Museum, the ancient Egyptian may have had to look as sharply after the coffins of his grandfathers as the modern Englishman after his chairs and tables, to prevent them from becoming worm-eaten.

Belonging to the same family as the Bacon Beetles are a few other insects that sometimes augment our household fauna. One of these, called *Attagenus pellio* (Fig. 11), is very much like a small *Dermestes*, both in form and in life history. It is a black insect, about one-fifth inch long, with a small but bright white spot (composed of hairs) nearly in the centre of each elytron, and also three similar but less brilliant ones on the hinder edge of the thorax, of which the centre is the most conspicuous.

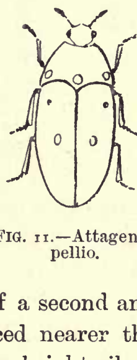


FIG. 11.—Attagenus pellio.

There is also usually a slight indication of a second and much smaller spot on each elytron, placed nearer the thorax and more at the side than the two bright silver points before alluded to. Of course, all these spots, being simply composed of hairs, easily become obliterated by the wear and tear of life, friction against obstacles causing their speedy abrasion.

This insect is of very similar habits to a *Dermestes*, and in domiciling itself with us may generally be regarded

as being engaged in fur-hunting. The name "pellio," which is Latin for a "furrier"—a preserver of and dealer in furs—is somewhat contradictorily given to this destroyer of such wares. Linné, who says that it will sometimes entirely strip a fur garment of its hair, accuses it also of attacking the household stores of food, and, besides this, it is occasionally a nuisance in Natural History collections, and has sometimes eaten holes in carpets. Its larva is closely covered with reddish-brown hairs, which give it a shining silky appearance, and it has a long brush of hairs at the tail.

Our last representative of this family is a much smaller insect, which has nevertheless rendered itself notorious by its invasion of museums—a fact, the memory of which has been perpetuated in the second half of its name, *Anthrenus musæorum* (Fig. 12). It is a short oval insect, about one-twelfth of an inch long, prettily sprinkled with variegated scales, which give it a mottled appearance, the pale ones on the elytra being distributed in three more or less distinct, irregular, transverse bands. The scales are pretty objects for the microscope. They are triangular in shape, and, of course, attached by the apex of the triangle, and their principal colours a very deep brown and pale yellowish-white. On their removal, the whole insect appears black.

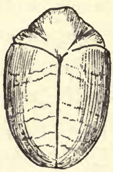


FIG. 12.—Anthrenus musæorum, as it appears when feigning death.

In the power of feigning death, by bending the head under and packing up the legs, this insect is quite equal to the most obstinate of its allies. The larva is hairy, like that of *Dermestes*, but, of course, much smaller. Its hairs are in bundles, and at its tail are a pair of tufts of larger size; when it is at rest these two are laid along the back, but when disturbed it erects them, and

spreads them out like a couple of shuttlecocks. On account of its hairy nature it is a very slippery creature, and this, combined with its small size, makes it a difficult captive to hold, and enables it easily to slip between the fingers. It is nearly a year in attaining its full size, though not equally vigorous during the whole time; it is much more active in summer than in winter, and feeds chiefly during the warm weather. At length, after several moults, the time for pupation arrives; the last larval skin, however, is not thrown off as its predecessors have been, but, a slit having been made down the back, the insect becomes a chrysalis inside the hairy shroud, from which, on attaining its final form, it makes its exit at the aforementioned slit, leaving its last two coverings one inside the other.

Five species of *Anthrenus* are known as British, and it is curious that the perfect insects frequent living flowers, especially those of the Umbelliferæ, in which they may sometimes be found gregariously. The larva of *A. musœorum*, however, feeds upon skins, hairs, feathers, and other dried remains of animals, though it is difficult to understand what temptation there can be for an insect's taste to oscillate between fragrant and aromatic flowers on the one hand and evil-flavoured and malodorous animal remains on the other. Apparently, however, it is not much affected by smells, for the powerful odour of camphor, which is destructive to many insects, seems not to incommode it at all; and, therefore, the keeper of natural curiosities will not permit himself to be deluded into the persuasion that all must necessarily be right with his collections if he has but applied camphor to them after the usual manner. This is no effectual preservative against *Anthrenus;* in fact, the wretched little creature has actually been found

snugly nestling under the very camphor that had been inserted for its destruction, in utter scorn of all such precautions. Its smaller size, too, renders it a more difficult enemy to guard against than *Dermestes*, as it can both enter through smaller interstices and is less conspicuous, though not less destructive when once an entrance has been effected.

Still keeping to the great section of the Club-horns, we come now to a minute insect called *Mycetœa hirta* (Fig. 13). This little creature has been at times bandied about from one family to another, and its true location is difficult to determine. It is only one-sixteenth inch long, of a pale chestnut colour, with rows of large and deep (comparatively) pits or "punctures" on the elytra (the word punctures, as used in entomology, does not imply complete perforation, but merely indicates sudden and minute depressions, usually circular in form); the whole surface of the insect is beset somewhat scantily with long coarse hairs, which stand out like *chevaux-de-frise* all over its body, and have gained for it the name of *hirta*, "hairy." The thorax seems as though its lateral edges had been turned up, folded back, and fastened down along the sides of the dorsal surface, somewhat as the edge of a piece of needlework is folded over to make a "hem." It is obvious, when one remembers the small size of the insect, that none of these peculiarities can be seen without the aid of a lens. This little insect is an inhabitant of old wine-cellars, where it feeds upon the fungoid incrustations on the walls, and, according to some, also attacks the corks of the bottles. Some people, however,

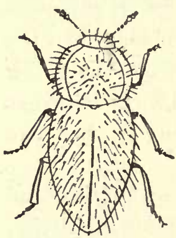


FIG. 13.—Mycetæa hirta.

believe this last charge to be unsubstantiated, considering the real damage to have been done by other insects found in the cellars, in which case *Mycetœa* has got into ill repute through association with evil companions. Its larva is a whitish fleshy grub, with six small legs in front.

In its cellar experiences, this insect is often accompanied by other minute beetles, especially certain tiny yellowish-brown ones of the genus *Cryptophagus*, a word derived from the Greek, and signifying an "eater in concealment." This is a large genus, and a very puzzling one, on account of the great similarity of the species. They may easily be distinguished from other small, similarly coloured beetles by the fact that the lateral edges of the thorax are produced into tooth-like projections, which differ in shape and position in the different species, but are almost characteristic of the genus as a whole.

CHAPTER III.

CELLAR BEETLES AND MEAL WORMS.

THE beetles whose ravages and life history have already occupied our attention illustrate very well two of the great primary divisions of the Coleoptera, viz., the Teredilia or wood-borers, containing the Death Watch and its allies, which are all summed up in a single small family, and the Clavicornia or Club-horns, to which the Bacon Beetle and its skin-devouring relatives are referable. We thus see that in each section, out of some hundreds of species of more or less similar structure, only a very small proportion, and those almost entirely confined to a single family in each case, bring themselves into collision with human household interests.

And in the same way, to get our next illustrations, we must go to another great primary section of the order, and select a few species therefrom. This section is called the Heteromera, a word which, being literally translated from the Greek, means "different joints,' and is given in reference to a peculiarity by which these insects are sharply distinguished from most of those already referred to, viz., that while the tarsi, or feet, of the first two pairs of legs consist of five little joints succeeding one another in longitudinal row, those of the hind pair have only four such joints, our preceding examples, except the little oddity *Mycetœa*, having been furnished with five on all their limbs.

The Heteromera are a remarkable set of insects, more fully represented in tropical countries than in our own islands. We possess less than 120 species, and these do not all rightfully belong to us; but even this small number includes insects of such diverse habits and structure as to necessitate their subdivision into nearly sixty genera. The economy of some, too—such as the familiar oil-beetle—is more wonderful than that of any other Coleopteron whatever.

Our first example from this group is the insect known to science as *Blaps mucronata* (Fig. 14), and popularly

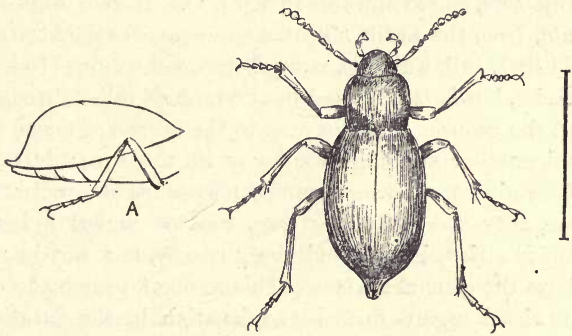


FIG. 14.—Blaps mucronata. A, side view of elytra.

called the "Churchyard Beetle" and "Cellar Beetle." It is utterly unlike any other British insect, except the other two members of its own genus, and these it resembles so closely as to be with difficulty distinguishable from them. It is a dull-black creature, nearly an inch in length, with long, straggling legs, and without wings, though the wing-covers, or elytra, are even more largely developed than usual. These cannot, however, be opened, and are, indeed, actually fastened together—"soldered" is the technical term—along their central

line of junction, thus forming a flattened arch over the body.

It shows no trace of ornamentation on any part of its body, not even the customary longitudinal furrows and rows of punctures so characteristic of beetles; and at first sight the integument seems to be perfectly smooth. Examination with a lens, however, reveals a minute and indistinct, irregularly scattered punctuation. The body is broadest a little behind the middle, and at the tail the elytra, instead of terminating in a smooth, evenly rounded edge, are each produced at the tip into a blunt projection, curled upwards (Fig. 14, A). The name *mucronata*, from the Latin *mucro*, a spear point, refers to this odd little tail, which is, nevertheless, not confined to this species, but is represented in one form or other throughout the genus. Turning next to the organs of sense, we find another striking peculiarity in the eyes: instead of forming projecting rounded masses, as is usually the case, they consist of two long, narrow, almost kidney-shaped strips, just behind the antennæ, and not raised above the general surface. This want of prominence of the visual organs finds its explanation in the darkling habits of the creature. Finally, the last four joints of the antennæ are like round black beads.

Blaps has really very little to recommend it. Its dull sombre aspect is the reverse of attractive, and agrees well with the retirement and obscurity of its life. Clad so completely in the deepest of mourning, it could not be let alone by superstition, and has therefore been regarded with terror as an ally of the powers of darkness, and an associate of death—a creature whose natural abode could be none other than a charnel-house. Ideas so fostered found apparent support in the repulsive odour it continually emits, resembling that of putrid flesh, and

in its not unfrequent occurrence in churchyards. Its disgusting odour is produced by the vaporisation of a fluid found in two oblong vesicles near the tail.

An unusual length of legs is generally an indication of agility, but not so with *Blaps*, which is a very tortoise in speed. It leisurely lifts one leg after the other, cautiously bringing them again to the ground, as though its vitality were well-nigh exhausted, and these were its last feeble efforts before giving up the ghost. Nothing could be farther from the truth, however, for its stock of vitality is extraordinary, and enables it to survive dangers and difficulties which would speedily be fatal to less hardy creatures. About a century and a half ago, when entomology was hardly yet a science, and the means of destruction of insect life not so varied or efficacious as at present, a struggle, so celebrated as to have been thought worthy of permanent record in the "Transactions of the Royal Society," took place between a *Blaps* and an entomologist. The latter made no less than four different attempts at the execution of the former, by immersing it in spirits of wine for periods of increasing length, the last extending over some twelve hours. On each occasion life appeared to be extinct, but each time also, on being removed from the fluid, the apparent corpse became reanimated, and the victim of alcoholic excess entered on a new lease of life, till at last the sentence was remitted, and the insect lived with its captor unmolested for three years afterwards, and even then the record of its experiences was brought to a close, not by its own decease, but by the carelessness of a domestic, who allowed it to escape.

This insect is often found in cellars, stables, and outhouses, dark and damp spots being especially congenial to its tastes. It shuns the light of day, and is chiefly

nocturnal in habits. Though so disgusting in smell, it found a place in the Materia Medica of the Romans, being recommended by Pliny as an infallible remedy in the case of ulcers which would yield to no milder treatment.

The larva is a long narrow creature, with six short legs in front, very similar to an ordinary meal worm, to which, indeed, it is not very distantly related. It is of a pale, yellowish-white colour, and not hairy, like those of the *Dermestidæ.* This, therefore, is the third type of larva we have met with: the first, of the *Ptinidæ*, plump, fleshy, soft, pale, and curved; the second, of the *Dermestidæ*, densely hairy, like moths' caterpillars; and the third, that of *Blaps*, long, narrow, and smooth. The larva of an allied species has been turned to account by the women of Egypt, who, following the precepts of "insectarianism," are said to make a savoury dish of the grub by roasting it and serving in butter, partaking of it with a view to the cultivation of *embonpoint.*

In order to find the other household members of the Heteromera, we must leave for a time the cellars in which we were hunting for our first representative of the group—the foul churchyard beetle—and visit localities of an altogether different description, viz., bakers' shops, bakehouses, flour-mills, and granaries. Farinaceous substances, such as wheat, barley, maize, meal, flour, bread, cakes, &c., are specially liable to the attacks of various species of beetles belonging, curiously enough, to several totally distinct sections of the order. In stores of corn in granaries no less than eighteen species of beetles have been found amongst the refuse, though it is probable that several of these were there, not to eat the grain themselves, but to prey upon such of their

associates as were addicted to that practice. Still, it is certain that there is a gang of nearly a dozen species that will engage in this work of destruction whenever they can get a chance, and the ringleaders are those two great sinners, the corn and rice weevils. As these, however, belong to the granary rather than to the dwelling-house, we need not stay to describe them here.

Our old friend, the omnivorous *Niptus*, sometimes joins the ranks of these "corn-lovers," and Dr. Power records having found it in hundreds in a quantity of meal, which he transferred to a closely stoppered bottle, where, notwithstanding that the bottle was never opened, the insects continued to breed for three years, though in gradually decreasing numbers.

But our concern at present is with the Heteromerous members of this gang of freebooters. They are chiefly of small size, and none of them equal *Blaps* in stature. By far the largest are those whose larvæ constitute the well-known "meal worms," belonging to the genus *Tenebrio*, from which the whole family is named the *Tenebrionidæ*. The meal worms themselves we reserve for a future notice, and turn our attention at present to the smaller species.

First, we have two very closely allied insects, called *Tribolium ferrugineum* and *T. confusum*, the former of which (Fig. 15) is much the commoner. They occupy a position very inferior to the corn-weevils in point of destructiveness, but still they are an enemy not to be despised. They are both small, dark, reddish-brown insects—a colour referred to in the name *ferrugineum*, "rusty"—of insignificant appearance, and, like several others of the group, do not rightfully belong to the

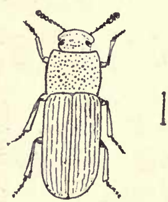


FIG. 15.—Tribolium ferrugineum.

British fauna, having been introduced here with foreign merchandise. They have, however, established themselves, at least under the shelter of human roofs, where they will breed freely, and therefore, though they do not yet appear to have become naturalised in the truly wild condition, they are usually included in lists of British insects.

They are so much alike that to a casual observer they would appear identical. By a very close and careful comparison under the microscope, minute points of difference in the antennæ, thorax, and punctuation can be made out, but these are of too minute and technical a character to be rendered intelligible here. In the name *confusum*, the "confused," given to the second species, we have an indication of the difficulty that attends their separation, and of the probability of their being confounded together. There is one peculiarity, however, possessed in common by these insects and their allies which is worth notice; it is that the eyes, which look like piles of tiny, polished, black beads, are much encroached upon by a projecting ridge in front of the head, which is produced backwards in such a way as to appear to have grown partially across the eyes, almost entirely dividing each mass into two unequal parts, one above, the other beneath.

The larvæ of these insects are tolerably active, somewhat hairy creatures, with six short legs in front. In common with larvæ generally, they change their skin several times, each time making their exit from the slough through a slit along the back of the neck, dragging out therefrom, first the segments that afterwards become the thorax, then the head and legs, and finally the abdomen.

Previously to assuming the pupal form, they become

restless, and search about for a suitable place of lodgment; having found one to its taste, the grub arches its back and divests itself of its last larval skin, and then passes very rapidly through the resting-stage of pupadom, appearing in an incredibly short time as a perfect insect, ready again to take part in the activities of life. At first it is pale, and the elytra are so transparent that the body can be seen through them; after a few days, however, they acquire their characteristic ferruginous colour and opacity. The pupa shows distinctly all the parts of the perfect insect, the head, wings, and legs being bent down underneath the body.

These insects do not confine their attentions to farinaceous substances; they are also animal feeders, and are amongst the enemies to be dreaded by the keeper of collections of natural objects; their larvæ will excavate the carcase of a dried insect as effectually as will those of *Dermestes* or *Anthrenus*.

Another bakehouse insect is *Gnathocerus cornutus*, which is identical in colour with *Tribolium*, and very similar in shape, but somewhat larger. Its names, *Gnathocerus*, "jaw-horn," and *cornutus*, "horned," both refer to a peculiarity of the male only, by which that sex can be easily distinguished from all other members of this group. The mandibles, *i.e.*, the biting jaws, are each in the form of a long horn, the pair of which, projecting considerably in front of the head, and curling upwards, give the insect a most formidable aspect. The head (Fig. 16) is altogether an odd-looking object,

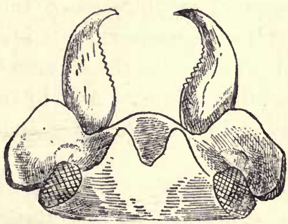


FIG. 16.—Head of Gnathocerus cornutus (much magnified).

for, besides these mandibular horns, there are two blunt horns on the forehead, and the ridge that almost divides the eyes is produced into a kind of flap or scoop on each side.

By these remarkable structures we are reminded of what seems almost like a law in the insect world, viz., that of all the different parts that make up the whole organism of a typical insect there are some, such, for example, as the legs, that preserve a very great uniformity of type throughout the class, varying in the different groups, and through the thousands upon thousands of species, only within comparatively narrow limits, while others seem possessed of much greater plasticity, so to speak, and run off occasionally into such eccentricities, extravagances, and apparent monstrosities, that it seems as though there were no limit to the modifications of which they are capable. Perhaps the best illustrations of this are to be found in the thorax and antennæ, in both of which most marvellous and unexpected developments, both in shape and size, are to be met with. And in our present insect we see the head and mandibles partaking of this same tendency to fantastical modification, a tendency which, so far as mandibles are concerned, is manifested in a most remarkable degree also in the stag-beetle, the "horns" of which are really its jaws. And in that case, too, as in the present, it is in the male sex that the structural peculiarity is found.

We conclude our notice of the family *Tenebrionidæ* with the creatures called "meal worms," which are the larvæ of two species of beetles, *Tenebrio molitor* and *T. obscurus.* Both larvæ and perfect insects are found in granaries, flour-mills, and bakehouses, where they

sometimes do much damage to meal, bran, and flour. The larvæ are much more familiar objects than the imagos, though probably the reverse is the case with the rest of the family. They are used as food for certain singing-birds, and other insectivorous creatures, and hence are bred in large numbers by bird-fanciers. This may readily be done by keeping them in bran, when they will propagate themselves freely. The word *Tenebrio* is Latin for a night-walker, or lover of darkness, and, so far as the mere meaning is concerned, the name would be just as applicable to the rest of the family as to the present insects, the whole set being devotees of obscurity. *Molitor* is Latin for grinder of corn, and *obscurus* finds its explanation in the dull appearance of the second species.

T. molitor (Fig. 17) is a narrow, parallel-sided beetle, a little over half-an-inch in length. Above, it is almost

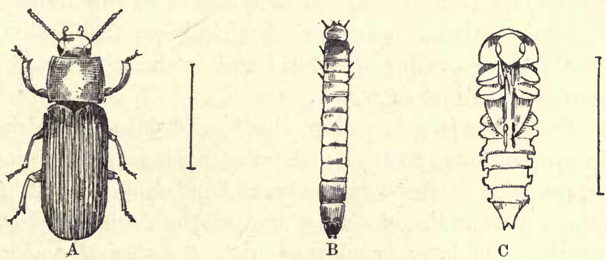


FIG. 17.—A, Tenebrio molitor; B, larva of ditto (natural size); C, pupa of ditto.

black, the faintest possible tinge of a dark brown-red preventing it from being quite so; or perhaps it might be more correctly described as deep brown-red, so deep as to appear almost black. Beneath and in the legs the lighter colour is much more apparent. It is slightly shiny, but only just sufficiently so to be redeemed from

the utter dulness and dinginess which characterise its relative, *T. obscurus*. Down the elytra run the inevitable parallel furrows, sixteen in number, not deep, but distinct enough to form a little "set-off" to the otherwise uninteresting appearance. The front of the head forms a ridge, which, as in some other species previously referred to, encroaches considerably on the eyes. The legs are rather short, and the antennæ are inelegant, thick, and stumpy. Unlike *Blaps* it is furnished with wings, and therefore, of course, the elytra are not soldered together.

T. obscurus is a trifle larger than *T. molitor*, perfectly dull black above, without a trace of the red-brown tint, which, however, appears again on the under side; in other respects it is almost the exact counterpart of its slightly less inelegant congener.

Such are the parents of our meal worms. The "worms" themselves (Fig. 17, B) are as different as can well be imagined — long, narrow, cylindrical, caterpillar-like creatures, consisting of a head and twelve similar and perfectly distinct segments.

The colour is pale yellow, shading off into yellowish-brown towards the head and tail. Each segment at its hinder edge carries a rather broad band, and at its front edge an exceedingly narrow one, of the darker colour, so that the body is adorned with a series of double rings encircling it at intervals along its length. The last segment is rounded behind, and terminates on its upper surface in either one or two small black curved hooks.

The head is furnished with a pair of not very large, but nevertheless strong, dark brown jaws, which, in repose, close in between the upper and lower lips, so that only their outer edges are seen. There is also a pair of tiny antennæ.

Under the three segments immediately succeeding the head are three pairs of short legs, each terminating in a sharp curved claw. By means of these the "worm" is able to progress at a tolerably rapid rate, provided there are sufficient irregularities in the surface to afford foothold to its tiny claws; but if transferred to a polished surface it presents a ludicrous spectacle; the front part of the body makes mighty efforts, struggling vigorously with its legs, and twisting itself from side to side, in vain endeavours to stir the inert mass of legless body which acts like a drag behind. The two legs in each pair are moved forward simultaneously, and the order of movement, which is not always quite uniform, and is extremely difficult to follow, appears generally to be first the front pair, then the third, and lastly the second. As the insect walks along, that part of the body immediately over the legs is, of course, somewhat raised, but the head is kept near the ground, so that it may feel its way with vibrating antennæ and palpi. When walking slowly, or endeavouring to extricate itself from a difficult position, it also makes use of a pair of fleshy tubercles underneath the front part of the terminal segment, thereby either helping the hinder part of the body forward, or acquiring leverage for the proper action of the legs. But when trotting briskly along there seems to be no necessity to call these tubercles into play, and the hinder part of the body therefore simply trails helplessly over the ground.

When fully grown, the larva is nearly double as long as the beetle it produces, but what the latter loses in length it gains in breadth, as it is fully twice as broad as its ancestral worm. Having spent some months in devouring farinaceous substances, and changed its skin several times during that period, the "worm" enters

its penultimate stage by another moult, but without forming any cocoon. It is now shorter and broader (Fig 17, C), no longer a roving pirate, but a restful helpless mummy, giving prophetic indications of its future destiny in its altered form—a beetle to all intents and purposes, but a caged and helpless one. After a few weeks the needful changes in its internal economy have been accomplished; it throws off its last skin, and appears a fully developed winged beetle, at first soft and red, but destined soon to acquire its natural firmness and pitchy colour. Previous to every moult, the meal worm acquires a bloated appearance, and becomes inactive for a time, lying on its side in a curved position, and resenting all interference with petulant twitchings of its form.

These meal worms will attack bread, cakes, &c., as well as uncooked cereals, and they have also been accused of devouring corks.

When we remember how many different species of "corn-loving" beetles occur in our corn-stores, and how excessively abundant some of them are, we are forced to the conclusion that many must often be ground up with the flour, and that we, therefore, sometimes get our bread adulterated with pulverised beetles, and unconsciously become "insectarians" for the nonce. But "what the eye doth not see, the heart does not grieve over," and possibly we may not really be any the worse for this slight admixture of animal matter with our farinaceous diet, though there are not wanting those who have thought otherwise. Many of these "corn-lovers" are Heteromera, as we have seen, and to this section belongs also the blister-beetle, renowned in medicine, and no very distant connection of our *Tenebrios.* Moreover, a Brazilian species of *Tenebrio* is

known to eject from its body a caustic secretion, and some other allied insects cover themselves with a similar substance. Now, if our meal worms, &c., have properties at all analogous to those of Spanish Fly, this internal application of cantharides, even in homœopathic doses, might not, perhaps, be altogether desirable. Some, too, have supposed the celebrated corn-weevils to be prejudicial to health when in a comminuted state.

Flour is not the only article of food that is liable to adulteration in this way. Curtis, in his "Farm Insects," has the following uncomfortable and suggestive passage: "I have known bushels of cocoa-nuts (*i.e.*, of course, *cacao*) which were, every one, worm-eaten and full of maggots, with their webs, excrement, cast-off skins, pupæ, and cocoons all ground down to make chocolate, flavoured, I suppose, with Vanilla."

CHAPTER IV.

LONGHORNS AND PREY-HUNTERS.

One of the finest, though at the same time most destructive, divisions of the beetle order is that called Longicornia, or Longhorns. The beetles are many of them remarkably handsome, and of considerable size, and are readily distinguished by the great length of their antennæ, which, in some cases, many times exceed even that of the body itself. These insects, in their larval condition, burrow into the solid wood of timber trees, where they live, often from three to five years, devouring the heart wood, and utterly ruining the timber by excavating through it in various directions neatly cut galleries, which, commencing on the outside in a small and scarcely noticeable opening, constantly increase in diameter with the growth of the larva.

As a consequence of their longevity and the seclusion of their life, it not unfrequently happens that when an affected tree is cut down, and has been sawn up into planks, the latter contain some of the immature larvæ, which escape notice through their burrows not having been sawn through, and thus get conveyed into timber-yards, and even used in building construction, before their occupants have had time to complete the necessary arrangements for making their *début* in beetle society. After a while, however, this important era in the life of the insects arrives, and the beetles make their exit from

their burrows, only, however, to find themselves far away from their native forests, strangers in a strange land, and suddenly introduced into a human society, which is as astonished to receive them as they are to find themselves in its presence. In this way many fine exotic Longicorns have been captured alive in different parts of England, and this, too, is the explanation of the not unfrequent occurrence of the Longicorn beetle called the "timberman" in mines. They have been introduced in the larval condition in the timbers used in roofing and supporting the passages, and have sometimes established themselves and bred there. Various forest trees are liable to the attacks of Longicorn beetles, but, of course, it is those that burrow in fir-wood that are chiefly imported into this country.

So, then, there are some of these Longicorns that may every now and then be expected to turn up in houses. Our British species are few in number, and, as a rule, not common; still, I have received one of our smallest in considerable numbers from two different houses. It is a quaint little brown beetle, which is said to be partial to old wood-work, and is called *Gracilia pygmæa* (Fig. 18). It is a narrow linear insect, with antennæ only a little longer than the body, the length being produced, as in all this section, not by a multiplication of the joints, but by their individual elongation.

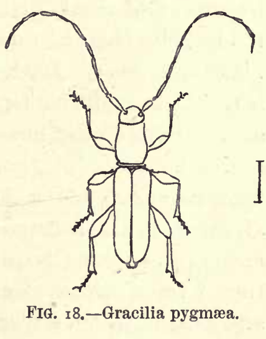


FIG. 18.—Gracilia pygmæa.

It is remarkable for the disproportionate size of the thorax, which, with the head, occupies about one-third the length of the whole body, and for the great breadth

of the thighs at their outer extremity. The antennæ, as might be expected, are very liable to damage, and as the insects are pugnacious, if several of them are confined together, they are sure to fight, and, as a consequence, a great mutilation of antennæ and legs ensues, the battle-field being strewn with the fragments.

It has also been found in large numbers burrowing in the twigs of a hamper, which, small though they are, afford plenty of scope for our pigmy beetle. Baskets form, in one way or other, an easy means of transference for insects from one country to another. Many continental species are brought over with fruit and vegetables, and the Borough Market, in London, is quite noted for the number of such insects that have been found alive there. About twelve years ago, a French Longicorn was introduced in large numbers by means of a basket; some escaped, and were afterwards found in the open, when it seemed as though a new British beetle had been discovered. Fortunately, however, their captor was a coleopterist of repute, and he, by means of careful observation and inquiry, managed to elucidate their history. The account is best given in his own words: "During the July of 1880, one of my servants brought me two specimens taken in the garden at the back of the house (the only two specimens then noticed). Last July, however (1881), two or three more were captured, and a day or two after they called my attention to the fact that numbers (dozens, in fact) were creeping upon the floor in the scullery; upon examination, I traced them to an old basket used for potatoes, and generally kept under the slopstone, and consequently moderately damp; in this they showed their presence by numerous small round holes, about the size of a pin's head. The basket, on being submitted to a professional

basket-maker, was pronounced to be 'of French make, from Dutch willows.'" They had, therefore, evidently established themselves in the basket while in their native country, and subsequently accompanied it across the Channel, when it was used for the transport of vegetables.

The larva of a much larger beetle, called *Hylotrupes bajulus* (Fig. 19), has sometimes done considerable damage to the rafters of houses, not only perforating the wood, but even gnawing its way through sheets of lead with which the rafters were covered. Kirby states that Sir Joseph Banks once gave him a specimen of sheet-lead, which, though only measuring eight inches by four, was pierced with twelve oval holes, some of which were as much as one-fourth inch in longest diameter. The generic name *Hylotrupes*, which is Greek for "borer of timber," at once stigmatises the insect as destructive in this way. The beetle is a blackish insect, covered with greyish down; and the name *bajulus*, which is Latin for a "labourer," is apparently given in allusion to the dusty appearance caused by this down.

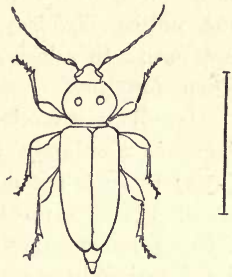


FIG. 19.—Hylotrupes bajulus.

The antennæ are of no more than ordinary length, so that at first sight it would perhaps hardly be taken for a Longicorn at all. The thorax is very globose, and carries two polished knobs on its upper surface. The thighs, like those of *Gracilia*, are clubbed, only more conspicuously so.

The larvæ of these beetles are fat, white, fleshy grubs, with small, but very powerful, black jaws—the tools by

which all the damage is effected. The pupa is formed in the burrows.

Fir palings in gardens sometimes produce plentiful supplies of a most lovely beetle, the resplendence of whose appearance is such as to suggest, though falsely, an acquaintance with the glowing rays of a tropical sun, instead of the comparatively feeble beams with which Old England is favoured. It is entirely of a most lovely violet or deep blue colour, and is shaped not unlike *Hylotrupes*, but flatter, and with longer antennæ. In allusion to its colour, it is called *Callidium violaceum.*

Here is a marvel in physiological chemistry! The larva is absolutely white, except for its little black jaws; there is not a trace of blue or any other colour about it, even up to the very time when it ceases feeding and changes into a chrysalis; and yet, during its larval existence, has been stored up in its body something from which, by the changes that take place during the pupal stage—a period during which no additional nutriment is taken—is elaborated the gorgeous hue which glorifies its adult form.

Longicorns are frequently very variable in size, as is usually the case with wood-boring insects. Imprisoned as they are in a burrow which, as larvæ, they never leave, they have very little power of selection of food, and are, therefore, entirely dependent upon the supply into the midst of which their excavating labours carry them; and according to the quality of this will be the vigour, or otherwise, of their constitution, and the stature to which they will attain.

We have only one other group from which to select examples of British household Coleoptera. These are

the most highly developed of all, the Geodephaga (or predaceous ground beetles, as the name signifies), which in classification are placed at the head of the whole order. Two species of this important group are found in cellars and dark outhouses. They closely resemble one another in shape, but, nevertheless, may easily be distinguished, both by size and colour. The larger, *Sphodrus leucophthalmus* (Fig. 20), which is also a bakehouse insect, is black; and the smaller, *Pristonychus terricola*, of a steel-blue colour. Both are exceedingly active, as well befits creatures which carry on a perpetual warfare against their smaller and weaker brethren, and subsist by rapine; indeed, the whole section Geodephaga are renowned for the extraordinary agility of their movements, in which characteristic they surpass all other Coleoptera, and in conformity with these habits, their legs are long and slender. The name *Sphodrus* is Greek for the "active, violent, or vehement one," and so far as mere meaning is concerned, would be equally applicable to almost all the Geodephaga.

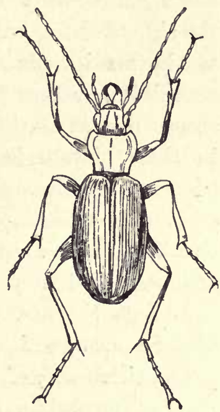


FIG. 20.—Sphodrus leucophthalmus (natural size).

Sphodrus is a fine insect, fully an inch long, but *Pristonychus* attains little more than half this length. They are so similar in shape that a figure of one will be quite sufficient to enable both to be recognised. The most elegant part about them is the thorax, which is of the form called by entomologists "heart-shaped"—that is, the outline of the margins consists of a double curve on each side, the front half being convex and the hinder

concave. This has the effect of forming something like a waist, and of imparting an air of neatness and refinement, so to speak; and, therefore, even *Sphodrus*, though so large, can certainly not be considered either coarse or clumsy.

A formidable pair of jaws, with which the insects can give an unpleasant nip, if incautiously seized, project in front of the head like a pair of shears. The pair of small jointed appendages, like two minute antennæ, by the side of these, are maxillary palpi, or feelers, attached to the maxillæ or secondary jaws, which underlie the mandibles, or true biting-jaws. The insects lurk under stones and in dark corners, and if suddenly disturbed in their hiding-places, make the most frantic efforts to recover their shelter. They can always find plenty of food in the shape of the other cellar Coleoptera, to which we have already referred, and many other kinds of insects that frequent such situations.

Besides the more legitimate coleopterous inhabitants of our houses, which we have described in the preceding pages, there are, of course, plenty of stray visitors that may at any time turn up. On a fine summer day, windows into which the sun is shining brightly often have a considerable insect population, amongst which many beetles may be found, especially such as ladybirds and tiny rove-beetles. Sometimes great rarities may be met with in this way. Thus the Rev. W. W. Fowler records having taken off a lodging-house window at Hunstanton, two minute beetles which had scarcely ever been met with in Britain before, beetles which were not household species at all, but simply casual visitors which had flown in and been unable to find their way out again. The corridors of the Crystal Palace, similarly, often yield hosts of tiny beetles; and

there is one species that is specially noted as occurring there.

Our food, too, sometimes introduces us to more insects than we care for. House flies, drowned in milk or soup, or fossilised in bread, and caterpillars boiled with peas or cabbage, will, of course, at once occur to one's mind; and, indeed, considering the inquisitive nature of some of our household pests, it is a marvel that we do not get more of them served up to table than we do. Foreign beetles sometimes occur in brown sugar, easily hidden amongst the crystals as long as the sugar is in the solid form, but brought into undesirable prominence when it has been dissolved in our coffee. The only specimen my cabinet boasts of, of a certain species that is now reckoned as British, though, no doubt, originally imported, was thus fished out of a cup of tea. And it is not merely *small* insects that appear in this way. I once met with a fine large South American weevil in a gooseberry tart. It was a handsome species, of a purplish-brown colour, with some clear yellowish-white circular spots, and was about half-an-inch long. It was in excellent condition, and not in the slightest degree damaged by the cooking it had undergone, but able to be set up as a perfectly respectable cabinet specimen. I have known, too, of an instance in which the shell of a pond-snail came to table in a loaf, apparently having reached so strange a position through the medium of the water used in mixing the dough.

Beetles, too, may be found on our doorsteps, or climbing the walls of our houses. I once met with two specimens of a rare beetle, one, in fact, which has only of late years been recognised as British, climbing up a pillar just outside the front door of a house. Many may also be found in thatch. If an old thatched roof,

which has become black with age, be beaten with a stout stick, and the dust and rubbish that come out be caught in a bag, and afterwards carefully examined by shaking it over a piece of white paper, the beetles it contains will easily be seen. They are mostly exceedingly small, but some are very interesting forms. In birds' nests, built in the gutter or under the eaves, and in pigeon-cotes and fowl-houses, many species also habitually live. If a quantity of the filthy refuse that accumulates on the floor of a fowl-house be shaken over paper, hundreds of beetles will come tumbling out, some of them even sufficiently valuable to make amends for the unpleasantness of the method of obtaining them.

In country houses, if an old log be put on the fire, any insects it may contain, speedily finding their quarters becoming too hot for them, make their escape, and, as often as not, find their way to the window, when, of course, they are readily observed, and may be easily captured.

Here we may conclude the consideration of the first order of insects—the Coleoptera. In the next chapter we shall proceed to notice the second order—the Hymenoptera.

CHAPTER V.

ANTS AND WASPS.

Though the order Hymenoptera is a very extensive one, including, as it does, the bees, wasps, ants, ichneumon-flies, saw-flies, and gall-flies, it will not detain us long, as only a very few of its members can legitimately be claimed as household insects. Bees, saw-flies, and gall-flies are so intimately associated with living plants that there is nothing to tempt them indoors; and it is only amongst the parasitic ichneumon-flies and their allies, and the omnivorous ants and wasps, that we can expect to meet with domestic examples.

We will first take the ants. Of these insects we have one species that is found exclusively in houses. It is not a truly British insect, but has been imported with merchandise. It does not seem to have been noticed here before the year 1828, nevertheless it has completely established itself, and, having found supplies plentiful, and the climate of our houses congenial to its taste, it will, no doubt, remain with us. At different times it has been known to English entomologists under a variety of names. In the latest systematic work on this particular group of insects, the "British Heterogyna and Fossorial Hymenoptera" of Mr. Edward Saunders, it is called *Monomorium Pharaonis*, but it was formerly known as *Myrmica molesta* and *Diplorhoptrum molestum.*

Ants, as is well known, are what are called social

insects, that is, they form large communities, which are something more than mere collections of many individuals of the same species living in close proximity to one another (in which case they would be called gregarious, but not social); they form well-organised societies, the members of which share a common dwelling, and contribute to the common well-being by their united exertions in erecting or excavating the abode, in providing the common stock of food, and in rearing the young. Insects which manifest this social instinct exhibit the further peculiarity that the species is constituted not of two, but of three distinct factors, which are frequently called males, females, and neuters, though the last-mentioned are more suitably denominated workers. As far as British insects are concerned, the only true social species are ants, certain wasps, the humble bees, and the hive bee; and it is only in these that the three so-called sexes are found.

There is nothing comparable to the worker in any other British insects, whether Hymenopterous or otherwise. In the highest development of the social community, such as is met with in the hive bee, the males and females are simply concerned with the propagation of the species, whilst the various labours of the community are performed by the workers, who are themselves, as a rule, incapable of reproducing their kind, being a kind of abortive females. Now, in the ants, the males and females are, primarily at any rate, winged, but the workers are always wingless; moreover, the males and workers are usually smaller than the females, sometimes very much so, and the workers are usually also smaller even than the males. The males and females appear in the late summer or autumn, and the former perish after pairing, so that their period of perfect existence is a

very short one. The females, previous to undertaking the duties of maternity, lose their wings, which either drop off spontaneously, or are torn off by the workers. Winged ants, therefore, are only to be seen at certain seasons of the year; and the majority of the wingless creatures that we commonly speak of as ants, and that are so frequently seen running about on the ground, are merely the workers.

So much with respect to ants in general. We may now proceed to the study of the particular species above referred to, viz., *Monomorium Pharaonis* (Fig. 21). It is a minute reddish insect, which, though apparently not yet distributed throughout the country, being most plentiful in the south-east, is nevertheless very abundant where it occurs, and therefore, in consequence of its voracious habits, a source of considerable annoyance.

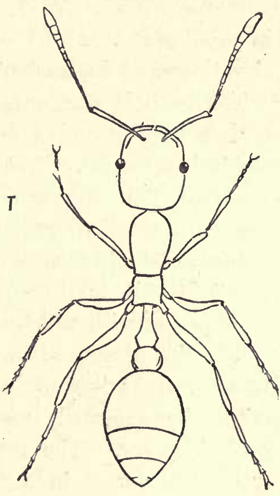


FIG. 21.—Worker of Monomorium Pharaonis.

The worker, the only member of the community usually seen, is reddish-yellow in colour, and is very minute, being scarcely one-twelfth inch in length, and so one of the smallest of our British ants. There is a peculiarity in the abdomen of this little creature, which at once reveals the family to which it belongs. British ants are divisible into three families—the *Formicidæ*, the *Poneridæ*, and the *Myrmicidæ*. The last is readily distinguished from the other two by the fact that the first two joints of the

abdomen are much narrowed, so as to form what is called a "petiole," because it seems as though the abdomen were united to the thorax by a kind of stalk; in the other two families it is only the first joint that is modified in this way. Microscopical examination shows that our present insect has two lobes to the petiole, therefore it belongs to the *Myrmicidæ*. These two lobes are considerably raised or swollen above, so that, when the insect is viewed in profile (Fig. 22), its contour presents a succession of elevations and depressions.

FIG. 22.—Side view of body of same.

The head is very large, and the antennæ are about half as long as the whole body, elbowed at the base and clubbed at the tip. Two black specks at the sides of the head are the compound eyes, which for an insect are unusually small in proportion to the size of the head. The abdomen is smooth and shining, but the rest of the insect is dull, in consequence of the minute and close punctuation with which it is covered.

The life history of an ant is similar to that of a bee. It commences life as an egg, which is very minute, as might be expected from the small size even of the perfect insect. The oval, yellowish-white objects so frequently found in ants' nests in the summer, and popularly called "ants' eggs," are not eggs at all—a conclusion the truth of which a little thought would at once render apparent, since they are as big as the insects themselves, and therefore could not be their eggs. From the eggs are hatched little footless maggots of a whitish or greyish colour, which are tended and fed with great assiduity by the patient workers.

In due course they become pupæ, in which condition

they resemble in shape the perfect insect, but have, as usual, all their limbs folded up underneath them. Previously to the assumption of this stage, some ants, such as the *Formicidæ*, envelop themselves in an oval silken cocoon, and thus acquire a resemblance to eggs; and it is these pupæ, thus enveloped, that constitute the so-called "ants' eggs" referred to above. But the *Myrmicidæ*, to which our present insect belongs, do not form cocoons, but pupate without this protection. The pupæ, since they are more helpless even than the larvæ, equally need the care of the nurses, though there is now no feeding to be done.

When the insect is ready for its final change, there is still more work for the nurses to do: they have to assist it out of its enveloping pellicle, to help it straighten its cramped limbs, to lead it about the nest, and generally to introduce it to all the activities of its new life.

We have said that these little ants have a voracious appetite; this the householder who is unfortunate enough to shelter colonies of them in his dwelling will soon find out. Nothing edible comes amiss to them, but they are specially partial to sweets and greasy substances. Cakes, pastry, sugar, and dripping may perhaps be said to be their especial favourites. Any dainty little morsels which the careful housewife has put away, as she thinks, in safety, ready for future use, are soon found out by stray members of the ant community. The news is telegraphed to the rest, and soon crowds are wending their way to the feast. When once they have assembled in considerable numbers at the place of entertainment, it is difficult for their human foe to know how to get rid of them. They are almost too small to be picked off by the finger, and the operation, too, would be somewhat tedious; an endeavour to blow them off might have just

the opposite effect to that intended, and cause them to adhere to the somewhat sticky compound they might be attacking; and altogether it is not surprising that maledictions are often showered on their devoted heads when they are caught in the act of pilfering.

It is extremely difficult to protect anything from them; they are so small that they will insinuate themselves into the smallest possible openings and crevices, and very little short of hermetical closing is of any avail against them. Should they happen to invade the home of an entomologist, he may well tremble for his treasures, for dead insects are just as acceptable to them as cakes or fruit. I remember having had in my young days several painful experiences of this kind. On one occasion I had just braced out on the setting-board a beautiful specimen of the Wood Leopard Moth (the first of its kind that had fallen to my lot), and had put it aside to dry; on looking at it the next morning I was horrified at discovering that two large holes had been excavated in its great fat body, and that as a cabinet specimen it was ruined; the crowds of tiny red robbers clustered round the insect, and, running over the board, told the tale of the origin of the holes, and many were the corpses that fell as an expiation. On other occasions I have had the bodies of small moths completely eaten up by these destructive little creatures while the specimens were drying on the setting-boards.

Monomorium is not the only foreign ant that has taken up its quarters with us, though by far the commonest. One or two others are found occasionally in hothouses, the high temperature of which serves to remind them of the tropical climate of their native regions.

The ants we have just been considering are genuine household insects, spending the whole of their lives in the shelter of our abodes, breeding amongst us, and bringing up their extensive families year after year in the same spot, as long as provisions are plentiful in the immediate neighbourhood. But this is not the case with the wasps, the next section of the Hymenoptera which will engage our attention. It is true that occasionally their nests are found in outhouses or lofts, or under the eaves of thatched roofs; but this is exceptional, and, as a rule, they enter our houses only in their adult condition; still, they are then such tiresome pests—at least, in imagination, if not always in reality—that we cannot forbear to grant them a place amongst our household insects.

Nothwithstanding the popular prejudice against wasps, there are many points of interest in connection with them. Their economy is remarkable, and inferior in interest only to that of bees and ants; their courage is certainly extraordinary; and though they are frequently an annoyance to us through their intrusive habits, yet there are, as we shall presently see, some counterbalancing advantages following from their mode of life; and, finally, their character is not really quite so black as it has been painted. That they are not, as some people seem to suppose, actuated by an irreconcilable hostility to human kind has been sufficiently demonstrated by observers, who, like Sir John Lubbock, have closely studied their habits, and have found it possible to tame them and make pets of them, and to induce even such fiery-tempered beings calmly to feed out of their hands, and to crawl over their persons without bringing their murderous weapons into requisition. Indeed, one observer, Dr. Ormerod, expressed

his opinion that they are much less fickle and more reliable than bees—an opinion, however, which will probably not be generally endorsed.

They will rarely attack unless provoked, and, though it is not easy to maintain a philosophic composure and indifference when a wasp is buzzing round one's head, yet such would no doubt be the best policy; at any rate, the violent flourishes and dashes so often made against them with handkerchiefs, knives, or what not, are more likely to irritate than to drive away insects so renowned for valour. Of course, when we attack their citadel, they will at once assume the offensive (as who would not?) and fight to the death for house and home. Very hot or windy weather, too, seems to bring out whatever spitefulness they possess; but this also is a psychological experience not altogether foreign even to *Homo sapiens* himself!

In distinguishing wasps from other Hymenoptera no reliance must be placed on the mere presence of yellow bands on the body, for though all wasps, of whatever habit, have these, such a style of ornamentation is by no means confined to them, but is of frequent occurrence throughout the whole order. But there is a certain peculiarity of the wings that will at once separate a wasp from the crowds of other yellow-banded insects. All wasps have four wings, and this will serve to distinguish them from certain two-winged flies of the order Diptera, with which they are sometimes confounded, but will not distinguish them from other Hymenoptera, as four is the natural number of wings in this group. But the anterior wings are folded longitudinally in repose, *i.e.*, when a wasp closes its wings it does not merely lay them along its back, as a bee would do, but also folds each fore-wing along a line

running from its attachment to the thorax to the middle of the outermost or rounded edge of the wing (Fig. 23), the lower and more flexible part being bent

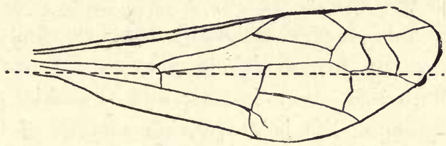


FIG. 23.—Wing of Wasp, showing line of folding.

under the rest, so that the wing becomes only half as broad as before.

In consequence of this peculiarity, the name Diploptera, or "doubled-wings," is given to that section of the order which contains all the wasps, and by this peculiarity they may at once be distinguished from all other Hymenoptera. One would naturally suppose that there must be some connection between this curious habit and the economy of the insects—something to account for so strange a departure from the general practice of the order; but if there be, it has yet to be discovered.

Our British wasps are of two totally distinct kinds. Those that usually obtrude themselves upon our notice are the *social* wasps of the family *Vespidæ*, and, like the ants and other social insects, they exhibit the peculiarities of the three so-called sexes, the common abode, and the common labour for the common welfare. But besides these, there are the *solitary* wasps of the family *Eumenidæ*, which, from their habit of burrowing in sandy banks, are often called Sand Wasps and Mason Wasps. These have but two sexes, do not form large communities, and, after having provisioned their nest with food sufficient to last the whole lifetime of

the larvæ, leave their young to take care of themselves. They are less robust than the *Vespidæ*, and though still yellow-banded, have a much larger proportion of black about their bodies.

It is only very occasionally that we find solitary wasps in our houses; their young feed upon small caterpillars and other insects, and the chief business of the parents' life is to provide a stock of these, so that they have not the temptation to intrude on our privacy which the *Vespidæ* have, for the latter are almost omnivorous, and there are plenty of things in our houses which suit their taste admirably. The solitary wasps of the genus *Odynerus* do, however, sometimes construct their small nests in the most outlandish places. The nests consist of separate cells, each closed in and complete in itself, and devoted to the use of a single grub. Each contains an egg and a store of little caterpillars, each stung by the mother wasp sufficiently to prevent it from being at all lively, but not sufficiently to cause it to dry and shrivel up.

These little clusters of cells have been found, amongst other strange places, inside the lock of a kitchen door, where, notwithstanding the noise and disturbance caused by the passing and repassing of persons continually going in and out of the kitchen, the mother built cells for her brood, provisioned them, and sealed them up, and the young went through all their metamorphoses successfully, appearing in the kitchen when they had assumed the perfect form, to the no small surprise of its inmates.

In the keyhole of an eight-day clock-case, too, one family was brought up, appearing to be in no way disturbed by the ticking or periodical winding-up of the clock. They have also been found in the drawer

of an old-fashioned looking-glass, in the folds of a piece of paper that had fallen behind some books, in hollow reeds used as thatch, and in the barrels of a pistol that was hanging invitingly on a post. In all these cases accident furnished the insects with cavities ready made, and saved them the trouble of excavating their own burrows.

These wasps are also sometimes seen in windows, buzzing about, apparently endeavouring to discover why a medium so transparent as glass should yet be able so successfully to bar their exit into the outer world.

The abdomen of an Odynerus is of a very curious shape (Fig. 24). In all the wasps, the first segment seems more or less like a cap on the succeeding ones, but this is much more markedly the case in the solitary than in the social species. In the genus *Odynerus* the abdomen bears a ludicrous resemblance to a peg-top surmounted by a polo-cap which is rather too small for it. The second segment is of enormous size compared with the succeeding ones, and being very convex above, forms the head of the top. This segment is black, except the hind border, which is yellow, and the succeeding segments are more or less deeply margined with the same colour. The basal segment, *i.e.*, the cap, is also furnished with a yellow marginal band, the shape of which is an important aid in the identification of the species. The folded wings and the top-shaped abdomen are quite sufficient to enable any one to recognise a sand-wasp.

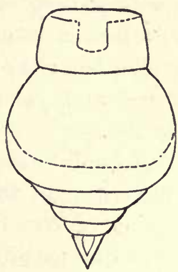


FIG. 24.—Abdomen of Odynerus.

CHAPTER VI.

SOCIAL WASPS AND HORNTAILS.

Of the *Vespidæ*, or social wasps, we have seven British species, including the hornet, which is by far the largest and most easily recognisable. The discrimination of the other species is not by any means an easy matter, and needs a very close attention to minute details. But the hornet is at once distinguished both by its size and colour; its hues are brown and yellow, instead of black and yellow, as is the case with all the other species.

Before, however, we can properly understand the differences of the species, or the reasons for their invasion of our homes and their pilfering of our food, it will be needful to sketch the life-history of a *Vespa*. As the plan is nearly the same in all, we need not at present particularise species, but only premise that we choose a subterranean, as being more common than an arboreal builder.

We begin with a fine old female, or queen, as she is called, whom the warmth of advancing spring has aroused from her long winter sleep. She is an ancient dame, one of the few relics of a past generation. She is, too, a widow, having lost her spouse at the advent of the previous winter, because his constitution, like that of all his compeers, was unable to endure the rigour of the frosty season. His progeny are all

posthumous, and even yet his widow is no more than an expectant mother. As she issues from her winter retreat, the responsibilities of life crowd thick upon her; she finds herself without a home, without a helper; and yet in a few short weeks she will be surrounded, in a commodious retreat, with hundreds of her own species, she herself not only their mother, but also their queen. She has no thought of returning to the old home which was the scene of her youth; that has long since been dismantled, and what with winter rains, and the invasion of earwigs, woodlice, and other such barbaric hordes, few traces of it now remain. So, like her mother before her, she has to undertake pioneer life, and to make a clearing for her future colony. Fortunate is she if she can find some hole—a deserted mouse-burrow, or other tiny cavern—ready to hand; much labour of excavating will thus be saved, and she may begin at once to form the nest. But should nature not thus favour her, she must herself set to work, and by repeated attacks upon the virgin soil with her powerful jaws, gradually hollow out a cavern to her mind.

She will then repair to some oaken fence, or row of palings, and with those same useful tools that she always carries with her, and that have just done such good service as excavators, she will snip off particles of wood, clinging to the fence all the while, gradually working her way along the paling, and leaving behind her a pale streak where the thin outer layer of weather-stained wood has been removed. With a bundle of woody fibres thus collected, she flies away home, and working them up into a pulp with a secretion from her own mouth, plasters them out into a greyish material that looks something like crumpled tissue paper. This is first formed into a kind of stalk,

attached at one point to the roof of her cavern—for, unlike most builders, she does not lay her foundations below, but builds from above downwards. At the extremity of this pedicle, three shallow, cup-shaped cells are formed of the same material, and placed vertically, with the mouth downwards; then a number of layers of the same papery substance are arranged above the cells, so as to form a dome-shaped roof.

Now there can be a commencement of egg-laying; each cell is furnished with one egg, which is glued to its side. The egg soon hatches, and the footless grub that issues from it is said at first to maintain its position in the inverted cell, and prevent itself from falling out of its bed, by a sticky secretion from its own body. The first batch of eggs produces workers, and it is essential for the queen to get them through their metamorphoses as speedily as possible, that she may have assistants to relieve her of some portion of her multifarious duties, which would soon become too onerous for her.

She has now to collect food for the hungry grubs, which cannot provide for themselves, and are entirely dependent on what she brings them. Sailing forth, she will soon seize a luckless fly or other small insect, whose corpse will be carried home, and doled out to the nestlings as they are able to receive it, their mother having made a previous mastication of the morsels. They open their little jaws, each armed with three teeth, and the mother puts their food into their mouths much as a bird would feed her callow brood. Fed several times a day, and fattening on such food, the ugly grubs increase rapidly in size, while the mother enlarges their cells as necessity requires, making them hexagonal in their upper part, and raising their walls by the addition of layer upon layer of her building material till the grubs are

ready to slip out of their larval skin and enter pupahood, when her constructive exertions cease, and the larvæ have now to look after themselves.

Each first spins a convex cap of silk, covering the open end of the cell, and then, in the seclusion of this snug retreat, shielded from the curious gaze of inquisitive neighbours, the incipient wasp is "unclothed" and "clothed upon." Not many days elapse before the final change occurs, and, in something under a month from the laying of the egg, the perfect insect is ready to join its mother in her exertions for the enlargement of the home, or rather to relieve her of them.

So batch after batch of workers is produced, and each, as it arrives at maturity, takes its share in the duties of nest-enlargement and feeding the young.

When one tier of cells has reached its appointed limits, another is commenced beneath and parallel to it, and connected with the former by sundry tiny pillars of the same *papier mâché*. We note here, therefore, three differences between a wasp's comb and that of bees, viz., first, the combs are made of paper instead of wax; second, they are placed horizontally instead of vertically; and, third, the cells are formed only on one side of the comb (the lower) instead of both. The number of insects produced cannot be accurately estimated from the number of cells, because several inmates often successively occupy each. It is manifest, therefore, that the population of the nest, including insects in all stages, is always in excess of the number of cells.

It is not till quite late in the season that the males and females are produced. They are both larger than the workers, and therefore occupy in their preliminary stages cells of larger dimensions than those mentioned above, and those of the females are placed in a part of

the nest more or less separate from the rest. The males, of course, have no stings, since this organ is but a modified ovipositor, but both females and workers are provided with them. The males, therefore, may be handled with impunity, and if only one could readily recognise the sex, there would be no hesitation in handling them. When all three sexes are seen side by side, there is little difficulty in separating the males, as their antennæ are longer than those of either of the others; but as this is a comparative character it is not so easy of application when only a single sex is seen. To some people, no doubt, a stingless wasp may seem altogether incredible, and, perhaps, contrary to experience; but it must be remembered that the majority of the specimens people in general meet with are workers, which regale themselves on our dainties, not for their own delectation only, but chiefly to minister to the wants of the grubs which are their care. The males live only for a short time at the close of the season, and, as they have not the important foraging duties of the workers to perform, they are not so likely to force themselves on our notice.

Wasps are easily affected by changes of temperature; as with most insects, cold has a benumbing influence on them, and consequently the first frosts of autumn begin to tell upon their numbers, and before long the whole population perishes with the exception of a few of the females, who manage, in the shelter of some retired spot, such as in moss or under bark, to survive the winter, and upon these hibernated specimens depends entirely the perpetuation of the species from season to season. Since, therefore, they are so dependent on climatic conditions, it is not surprising that their numbers are very different in different seasons; in some

years, as was the case in 1878 and 1880, they are so numerous as to be a positive plague, and in others comparatively few are seen.

In country places, wasps' nests are not unfrequently found in thatched roofs or under the eaves of houses, as well as attached to beams in lofts, barns, and outhouses. Even the ground-wasps sometimes select such situations, and the hornet, too, occasionally establishes itself in a loft or barn. Sometimes amongst thatch are found numbers of the rudimentary nests constructed by the queens only, which have never advanced beyond their primitive condition, having been, for some reason or other, abandoned shortly after their construction.

The insects themselves are quite omnivorous in their tastes; one might almost say, "Whatever man can eat, that wasps can eat." The swarms that, in a hot summer, crowd the windows of country grocers' and bakers' shops are a pretty good proof of this. Sweets of all kinds, including ripe fruits, are very attractive to them; but cakes and bread, or even meat, will also be readily devoured. Living insects, too, they catch in great numbers, especially flies, and it has been well remarked that, while they will at one moment be robbing the butcher by devouring his meat, they will at the next be making valuable restitution by devouring the flies that would lay their eggs upon it; and it is probable that the advantage that accrues to us through their destruction of so many disagreeable insects is more than sufficient to counterbalance any loss we may sustain through their attacks upon our fruit and other stores. In catching their insect prey they are very dexterous. Professor Westwood says, "I have watched the common wasp hovering over and darting hawk-like upon flies upon excrement, careful not to

soil its own legs and wings." So, too, they will pick flies off the backs of pigs in their styes. They are clever, too, in chasing and dodging insects to catch them on the wing. When the prey is caught, the wings, head, and legs, being more or less hard and dry morsels, are bitten off, and the rest of the body devoured. Flies, butterflies, and even bees are treated in this way. Unlike the *Odyneri*, they do not use their stings in giving a quietus to their prey; the action of their powerful jaws is quite sufficient, without the aid of the more deadly weapon.

They are most industrious in the obtaining of supplies, and well they may be, considering the number of hungry mouths they have so constantly to fill; greedy grubs, ever on the look-out for something good, demand all the energies of even the large staff of workers that are in continual attendance upon them. Sir John Lubbock records a case of one of his wasps, which paid no less than ninety-four visits to a store of honey in one day. And in the performance of these duties they are not only industrious, but wonderfully persistent, and undaunted by obstacles or dangers. The same diligent observer records several instances in point. One wasp had smeared its wings with the syrup on which it was being fed, and so rendered itself incapable of flight; Sir John, therefore, put it in a bottle of water, and gave it a bath, transferring it then to a dry bottle placed in the sun, as the best means of getting it dry. When quite recovered, it was allowed to go free, and after thirteen minutes it returned to the syrup-saucer that had been the scene of its former disaster, and began to sip the liquid with as much avidity as before, evidently quite undeterred by its sad experience. Another was immersed in water till quite insensible,

in other words, virtually drowned; on being taken out, it recovered after a while, and at once set to work again at the business of its life, as though there had been no interruption.

The head of a wasp is a remarkable structure (Fig. 25), and well worthy of a close and attentive examination, if only to see what a variety of adornment is lavished on even minute and otherwise obscure parts of the insect, and to marvel at the number of organs that can be collected into so small a space. The entomologist who wishes to distinguish the different species from one another must pay great attention to the minutiæ of this part of the insect, because some of the best distinguishing marks are to be found here. In shape the head is something like a triangular cake with the angles rounded off; it is set on the body vertically, with the base of the triangle placed horizontally, and forming the crown. In front it is slightly convex and behind concave, and it is attached to the thorax only by a small junction in the centre of the hinder surface.

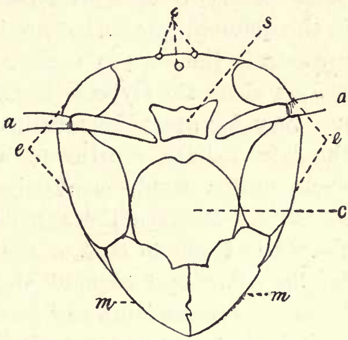


FIG. 25.—Head of Wasp: *a*, antennæ; *c*, clypeus; *e*, compound eyes; *m*, mandibles; *o*, ocelli; *s*, coronet spot.

The apex of the inverted triangle is formed by the meeting of the two exceedingly stout and broad jaws, or mandibles, each furnished on its cutting edge with an inner and an outer row of notches or teeth, separated by a groove. They move laterally, and are in most cases attached by a sort of hinge-joint just below the

compound eyes. The jaws themselves are yellow, but the teeth black. Occupying the centre of the head, just above the jaws, is an important and conspicuous organ called the *clypeus.* It is slightly projecting, and is like a broad plate with an outline which is curved above and angular below. This, too, is bright yellow, but it carries certain black marks upon it, which vary in the different species, but are in most cases sufficiently constant in the same to be used as diagnostic characters.

Just above the clypeus the two antennæ are inserted, not very far apart from each other, in the centre of the head. Each consists of a long basal joint, the *scape*, and a stout, many-jointed, terminal part, the *flagellum.* Between the antennæ, and stretching from the base of one to that of the other, is a remarkable bright yellow spot of most elegant shape. It usually bears some resemblance to a sort of coronet, and situated as it is, just above the equally brilliant yellow clypeus, it suggests, in conjunction with the latter, the idea of a nobleman's coat-of-arms surmounted by his coronet, as though the wasp were carrying the evidence of its rank and identity on its brow; and it is not a little remarkable that in this coat-of-arms, so to speak—viz., the combined clypeus and coronet—we really do find some of the best distinguishing marks of the species.

The sides of the head are occupied by the compound eyes, which, being situated just on the bend, of course command the most extensive horizon possible. They are reniform, or kidney-shaped, there being a deep indentation in their inner outline at that point which is just behind the antennæ when they are in their most natural position; and it would almost seem as though this limitation to the extent of the visual organs were in some way or other connected with the presence,

immediately in front of the spot, of the great black antennal scape, which would certainly render useless for direct vision any eyes situated immediately behind it. Yellow streaks bound more or less of the outline of the eyes, and greatly improve the appearance.

On the top of the head we see three small, polished, glassy-looking knobs, frequently of a ruby or yellow colour, and arranged in triangular form. These are the *ocelli*, or simple eyes, and their number and arrangement are both very characteristic of the order Hymenoptera. We find the same little organs in bees, appearing like tiny sparkling gems, half hidden by the hairs amongst which they are imbedded. In the ichneumon-flies, saw-flies, &c., we find a similar arrangement.

These are all the parts that are visible from above in the natural position of the organs; to get at the rest of the complex apparatus of the head we must open the jaws, and then underneath we are introduced to a bewildering collection of organs, as puzzling at first sight as a piece of modern machinery. But a little turning and twisting about, and examination from various points of view, soon enables us to make out the general plan and to see the relation of the parts to one another.

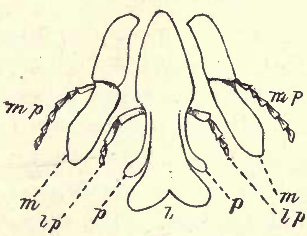


FIG. 26.—Labium and maxillæ of Wasp: *l*, labium; *m*, maxillæ; *lp*, labial palpi; *mp*, maxillary palpi; *p*, paraglossæ.

First, and just underneath the position occupied by the mandibles when closed, are two thin blade-like pieces beset with hairs pointing forward (Fig. 26). These are the terminal portions of the maxillæ, or secondary jaws, which, as well as the mandibles,

are capable of lateral movement. Tracing them back to their point of attachment to the head, we find that the basal part is of a somewhat more substantial character than the terminal, and that at the junction of the two parts, on the outer margin, each maxilla carries a slender six-jointed appendage, the maxillary palpus. When the maxillæ are moved aside, a single central organ, previously partly covered by them, comes into view; in its front part it is thin, flat, and band-like, but behind it is much thicker. This is the labium or so-called tongue. The flat portion is rather deeply bifid in front, and carries two narrow organs, the paraglossæ, attached to its sides, but not quite reaching the tip; thus the free edge of the labium presents four rounded divisions. Further back it carries two jointed appendages, the labial palpi; they are stouter than those of the maxillæ, and are only four-jointed. It is this tongue that the insect uses as a trowel in its plastering operations, when it is manufacturing its nest. When the mandibles are closed, they almost entirely conceal all this mechanism, only the tips of the palpi being visible.

From the above description it will be evident that a wasp's head is not quite so simple an object as it might at first sight appear; nevertheless, there is no great difficulty in making out for one's self all the above points. Only two tools are necessary, a needle to open out the mouth organs, and a hand-lens to examine the different parts. The examination is best conducted on an amputated head. The junction between head and thorax is so slight that there is no difficulty in decapitating a wasp (a dead one, of course!), and if a stout pin or the end of a match cut down to a point be inserted in the small hole that will be found at the spot where

decapitation took place, and the head be thus impaled after the fashion in which the authorities in this country once upon a time delighted to treat the heads of political offenders who had suffered death for their indiscretion, the head may be more conveniently handled and placed in any desired position for examination.

Of our seven British species of *Vespa*, the hornet stands by itself, both as regards size and colour, and may be conveniently left till we have considered the remaining six, which are more or less alike, and consist of three that form their nests underground and three that build in trees. The latter are *V. sylvestris*, *arborea*, and *norvegica*. The second of these we need not trouble ourselves about, as it is a rare insect, and not at all likely to be met with. *Norvegica* occurs principally in the north of our island, being fairly common in Scotland; and *sylvestris*, while generally distributed, is yet not so common as the ground builders.

The latter are *V. vulgaris*, the so-called "common wasp" (not that it is always the commonest, though often so), *germanica*, and *rufa*, and it is the two former of these that are most likely to fly in at our open windows and manifest a disposition to join us in our meals. On one occasion a large number of females of *germanica* were found gregariously hibernating in an upper room of a large building that was used for storing furniture. Some were amongst some blankets used in covering the furniture, and others were clinging to some rough woodwork, into which, as with a consciousness that their limbs would become benumbed and useless during the winter, they had firmly dug their mandibles. To give an idea of the proportionate distribution of these species, I may mention that a friend of mine in the

south of England, some years ago, on examining sixty wasps that had been captured quite promiscuously in his garden one day in the summer, found them to consist of twenty-four *germanica*, fourteen *vulgaris*, seventeen *rufa*, and five *sylvestris*. This, however, probably represents an unusually large proportion of *rufa*.

For the distinction of these six yellow and black species, we must look mainly at the face and the first segment of the abdomen. Turning first to the former of

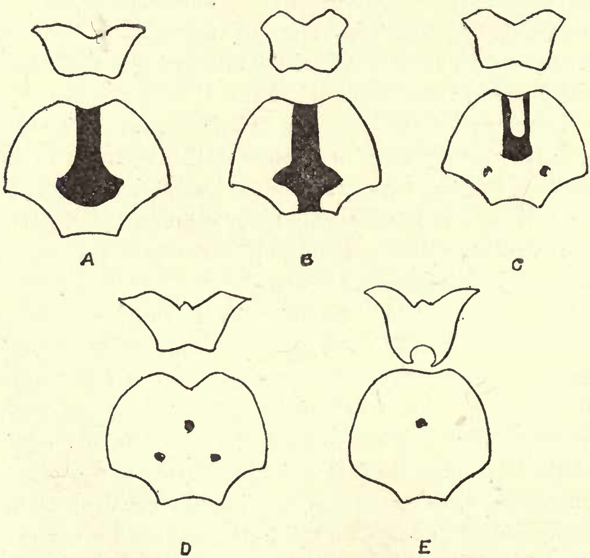


FIG. 27.—Coronet-spots and clypei of wasps. A, *V. vulgaris*, female; B, *vulgaris*, worker; C, *germanica*, worker; D, *germanica*, female; E, *sylvestris*, worker.

these, we examine carefully the central plate referred to on p. 74—viz., the clypeus—and are at once struck by differences here: in all the clypeus itself is yellow, but the black markings upon it vary (Fig. 27).

Vulgaris and *rufa* carry on the clypeus a vertical black stripe, descending, in the workers, from the centre of its upper edge to the centre of the lower, and more or less dilated near the lower extremity into two lateral projections. In the males and females the mark usually does not quite reach the lower margin of the clypeus, but terminates at these projections, and it thus acquires something of the appearance of a cheese-cutter with a long and stout handle. It has also been likened, with less justice, to an anchor, and hence both these species are sometimes called anchor-faced wasps. *Norvegica* also carries the anchor-mark on its clypeus; so that there are three species adorned in this way, two ground-wasps and one arboreal species.

Germanica, on the other hand, carries in the workers a central black stripe, stretching only part of the way down the clypeus, and often more or less imperfect, and two black dots placed triangularly with the free end of the stripe. In the males and females, there are usually simply three black dots, placed triangularly, without a black stripe at all. Lastly, *sylvestris* has only a single black dot in the centre of the clypeus, or, in the females, often no black markings at all.

Turning now to the basal segment of the abdomen, we find that *rufa* has some rusty stains around the black spots there, in addition to the yellow band which occupies the greater part of the segment; and the same rusty hue often occurs on other segments as well. It is from this peculiarity that the species derives its name (*rufa* = red). But it would not be safe to conclude that any anchor-faced, red-spotted wasp is *rufa*, since *norvegica* is usually similarly coloured; the red colour, however, will serve to distinguish *rufa* from *vulgaris*, both of which, it will be remembered, are anchor-faced.

The basal segment of *germanica* carries three large and distinct black spots in its yellow band, the centre of which is diamond-shaped; *vulgaris*, instead of this diamond, has simply an angular indentation. But these two species are sometimes very difficult to separate, especially the workers, since the markings on the abdomen vary a good deal, and even those on the face are not quite constant. *Sylvestris* is sufficiently separated from the rest by its single clypeal spot.

We still need a reliable means of separating *norvegica* from *rufa*. This is to be found in the compound eyes, which, in the latter species, are continued to the base of the jaws, but in the former do not extend so far. *Sylvestris* agrees with *norvegica* in this respect. We may add to these distinctions, that while the ground-wasps have a yellow stripe in the scape of the antennæ only in the males, the tree wasps have it in all sexes. As if, however, to prevent the use of this as a reliable diagnostic character, the female of *rufa* sometimes takes on a yellow stripe. The coronet-shaped spot, too, varies in the different species, but not in such a way as to be rendered easily intelligible in words; and the above distinctions will, in most cases, suffice for the determination of the species.

Few people seem to be familiar with the hornet, except by name; and two totally different insects are commonly mistaken for it. One of these is a large Dipterous, or two-winged insect, the largest *fly* we have in this country. It is a robust, black and yellow creature called *Asilus crabroniformis*, the specific name, which means "hornet-like," being given in allusion to the above error, *crabro* being the Latin name for a hornet. It is a common insect in the summer-time in many places (not indoors, however), and dashes about

with bold and vigorous flight and great buzzing, and with so martial an air that it is not surprising that those who do not know its real nature should be intimidated by it. It is, however, a perfectly harmless creature.

The other insect sometimes mistaken for a hornet comes a little nearer the mark, for it *is* hymenopterous; but still it does not belong to that section of the order which contains the wasps and other stinging insects. It is closely related to the group of saw-flies, and is one of the largest hymenopterous insects we possess. It is a yellow and black powerfully flying creature, called *Sirex gigas* (Fig. 28) (the specific name is given in allusion to its gigantic size), and the female, which is the sex most often seen, possesses a long and stout ovipositor, which looks dangerous enough, though it is simply a kind of auger, and not a poisonous weapon at all, so that the insect, though so formidable in appearance, is in reality harmless. This great ovipositor has acquired for its possessor the name of "Horn-tail."

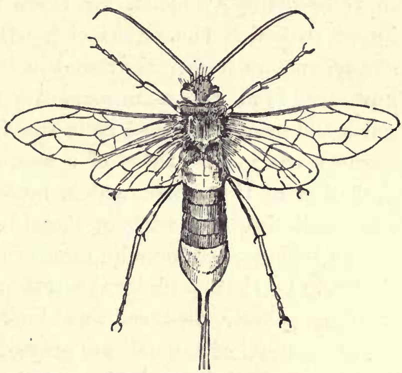


FIG. 28.—Sirex gigas (female), natural size.

Both the above insects are yellow and black, and, as we have already seen, the latter colour forms no part of the ornamentation of a hornet; moreover, when one comes to look at them closely, they are at once seen to be altogether unlike wasps, though, of course, when they

are on the wing, and dashing rapidly about, it is not so easy to see this. Now the hornet, the scientific name for which is *Vespa crabro*, i.e., reversing the order of the words, the "hornet wasp," is in shape exactly like an overgrown wasp, so that its form must be familiar to every one. We have only to imagine the yellow of the wasp's body to be deepened in tone, the black to be replaced by brown, and the whole insect to be considerably magnified, and the wasp becomes a hornet. If this be borne in mind, there should be no difficulty whatever in recognising a hornet, for there is no other British insect to which the description will apply. Since the *Sirex* is not unfrequently found in houses, as well as the hornet, it is all the more necessary to be able to distinguish the harmless insect from the dangerous one. The hornet's wings, like those of a wasp, are covered with a profusion of tiny hairs, which, however, are so small as to be quite invisible without the aid of a microscope.

The hornet constructs its nest of a material prepared similarly to that used by the rest of the genus, but it is of a coarser texture, and inclines to a yellowish brown, instead of the delicate grey of the smaller species. As an instance of the rapidity with which these insects work, the following particulars, given by Mr. R. S. Standen, concerning a hornet's nest found, in the summer of 1881, in a shed in Norfolk, may be quoted. It was constructed in a thin shell of mortar about the size of a lemon, and open at one end. It was commenced on June 24, and the writer goes on to say, "Although when I first observed her (the queen hornet) the shell was perfectly empty, by the morning of the 28th—less than five days—she had constructed twenty-six cells; two were empty, seventeen contained eggs, five had good-sized larvæ, and the remaining two were already

sealed up for the pupa stage." Prudential considerations at this moment suggested the advisability of putting a stop to the further development of this interesting colony, lest battle might have to be done against scores of winged warriors, instead of one solitary heroine; and the whole colony, together with its foundress, were accordingly massacred. Many other instances are on record of the occurrence of hornets' nests in sheds, lofts, and thatched roofs.

The *Sirex* mentioned above may now come in for a somewhat more detailed notice. It occasionally occurs in houses in the same way as the large Longicorn beetles referred to in a previous chapter; it is a wood-borer, and attacks fir-wood chiefly, and its larvæ and pupæ are therefore sometimes present in the timber used in the construction of houses; and, enclosed in this, the immature insect may be introduced into the edifice, the completion of its metamorphosis being delayed till after the timber has been placed in position, when it emerges, to find itself, not amidst its native pines, but an uninvited guest in society to which, on account of its size, its appearance, and its loud buzzing, it is often an object of unnecessary terror. Sometimes it does not issue from the wood for a considerable time, which may occasionally amount to years. Amongst other instances, there is a record of the emergence of several specimens from the floor of a nursery in a house that had been built for three years, and where, very naturally, they caused quite a fright to the children who were its occupants. Usually they occur in houses either singly, or at most in twos or threes, but sometimes considerable numbers have been met with; for instance, in the summer of 1878, no less than a dozen specimens were captured in an ironmonger's shop in Chichester. It is

obvious that in many cases these household specimens may not really be British at all, but, if the timber be foreign, may have been imported with it.

The female of *Sirex gigas* has a black head and thorax, and a long cylindrical yellow abdomen, with a broad black band, like a mourning band, across the middle. Behind the eyes, which are not situated on the bend of the head, as they are in wasps, are also two yellow patches, which are so conspicuous and shining that they might very probably at first sight be mistaken for the eyes themselves. The antennæ and legs are long and yellow, and the former are proportionately much longer than in the wasps, since they consist usually of about twice as many joints. The four large membranous wings are shining and transparent, though strongly tinged with yellow, and are without the minute hairs that cover those of wasps. When the wings are fully spread, the insect may measure as much as two inches across, but specimens are often found much smaller than this. Like all wood-feeding insects, they vary greatly in size. The abdomen is attached to the thorax by the whole of its base, instead of the slender peduncle that constitutes the familiar and proverbial wasp's waist.

But the most interesting part of the insect is the ovipositor, which consists of three parts, two yellow side-sheaths, which are toothed outwardly towards the extremity, and a black central borer, which is notched at the end, and is therefore able to act something like a gimlet. This instrument runs up underneath the abdomen, and has its origin more than half-way up the latter; it also projects beyond the abdomen to about the same extent, and measures almost an inch in total length. In addition to this, the last segment

of the abdomen is produced above into a long and stout spine, which is nearly half as long as the free part of the ovipositor. With the ovipositor the mother pierces the bark of the tree she has chosen for the support of her progeny, in order that she may deposit her eggs in such positions as shall place the young grubs in circumstances of comfort and opulence from the moment they first see the light.

Her consort is altogether a slenderer smaller insect, and has a reddish body, without the mourning band—and, of course, without the formidable boring apparatus; all he can show in the way of offensive or defensive weapons is a very sharp point at the end of the last segment of his abdomen, in the same position as the much larger spine of his spouse.

Sirex gigas is sufficiently large to show with tolerable ease a certain structure in the wings which is eminently characteristic of the Hymenoptera, though often too small to be readily seen. When spread out, the fore and hind wing on each side will be found to be in some mysterious way connected, so as to move in concert, and to offer, over the greater part of their area, one unbroken resisting surface to the air. If, however, they are waved about in various directions, they may at length be caused to spring apart, and then, if the front edge of the hind wing be held towards the light, the explanation of the mysterious union will be found. Here will be seen, running part of the way along the margin, a row of between fifty and sixty tiny hooks, bent upwards and backwards in such a way that when the wing is brought into position behind its fellow they clasp from underneath the stout nervure which bounds the forewing on its hinder edge, and thus hook the two wings together. In the centre they are placed

much more thickly than at the ends, and show a tendency to form two distinct rows. It is obvious that this arrangement greatly increases the power of the wings, and no doubt largely contributes towards that vigour of flight which is so prominent a feature in the Hymenoptera.

The larvæ are fat whitish maggots, with six very tiny feet in front, and the tail ending in a spine; and from their size, it will be easily understood that they work great havoc in fir trees in which they have established themselves, devouring, as they do, the solid timber. When the insect reaches the end of its larval life, it forms a silken cocoon in its burrow, and in this changes to a pupa, which, as is customarily the case amongst the Hymenoptera, looks like a mummy of the perfect insect. In this same burrow it enters on its perfect life by casting its pupal skin; but when thus freed, it has still to make its way into the open air; its burrow has already been carried as far as the bark of the tree, and it therefore has now to perforate the bark in order to escape from its prison. This it does by gnawing through it, and then creeping through the opening thus made. It often recruits its strength after its exertions by sitting on the tree trunk just outside for a time, before starting on its noisy flight.

When domiciled with man, however, its escape from its prison-house is not always so easy. At a military clothing-store in France, one of the shelves on which the clothes were piled contained a pair of *Sirices*, presumably in the larval condition when first introduced. On arriving at maturity, the insects proceeded to work their way out of the wood as usual, but when they reached the surface they found their further progress barred by the piles of clothing, which happened to

consist of a number of pairs of woollen trousers. Nothing daunted, however, they set to work upon these also, and pierced them in several directions, as they had previously done the wood, until at last they reached daylight, when, as a rather disappointing reward for their perseverance, they fell into the hands of one of the officers, who was himself an entomologist.

Like one of the Longicorn beetles before alluded to, this insect has sufficient strength and perseverance not to be hindered in its burrowing operations, even by so formidable an obstacle as sheet-lead, or, indeed, by a still thicker layer of the same metal. Two instances of this have been reported to the Entomological Society of France by M. Lucas. In one instance it was a lead-covered roof that was perforated, the lead being about one-eighth of an inch in thickness. The other was a very curious case. It occurred in an arsenal at Grenoble. A box of cartridges was discovered in which some of the bullets had been pierced by these insects, the explanation apparently being that the larvæ had been in the wood of which the box was composed, and that the perfect insects, in endeavouring to work their way out, had directed their course inwards instead of outwards, and had thus encountered the cartridges, through which they had been compelled to eat their way; some of them, however, had perished in the attempt, and they were found dead in the box, with their beautiful yellow bodies blackened with the lead and powder.

There is an allied species, called *S. juvencus*, in which the female has a shorter ovipositor, and is entirely of a splendid steel-blue colour. This also occurs in houses, similarly to *S. gigas*, which it equals in destructiveness as well as in size. Some years ago, no less than two hundred fir trees were destroyed by this insect on a large

estate in Norfolk. It seems probable, however, that the *Sirex* must not be charged altogether with this wholesale destruction; the insects appear to have a tendency to attack trees that are already enfeebled by disease or damage, instead of those that are vigorous and healthy, and, therefore, perhaps in some cases they merely accelerate a death which could not have been long delayed. Still, of course, when they do attack a tree, they often utterly spoil the wood as timber by their numerous burrows in all directions. As an instance of this, we may take a tree that was found in Bewdley Forest some years ago. Twenty feet of the length of this tree was so perforated by this insect as to be completely useless as timber, and serviceable for nothing but firewood. It was transferred to an outhouse, and while lying there for some months, the insects emerged from their burrows at the rate of some five or six a day. It is curious to note that the first specimens hatched were chiefly males, but, as time went on, the females became more numerous and the males less so, till at last only females appeared.

CHAPTER VII.

CLOTHES MOTHS AND OTHER TINEÆ.

In previous chapters we have studied the household representatives of the first two orders of insects, the Coleoptera and Hymenoptera; we may now pass to the third, viz., the Lepidoptera, or butterflies and moths. The insignificant but abominable pests referred to in the heading of this chapter will be at once recognised as very familiar examples of this order. The term clothes moth, however, like most popular names, is a vague and indefinite one, and in most cases it is not easy to say what insect really is meant when the term is used. Any small moth found indoors usually gets branded with this opprobrious epithet, which is thus applied indiscriminately to several species—to some justifiably, to others the reverse. There are at least half-a-dozen kinds of small moths that regularly and more or less commonly take up their abode with us; but while some of them are indeed fearfully destructive to woollen and other animal stuffs, others are either general feeders, or depend for their sustenance upon various vegetable substances, and, as a rule, probably do no harm to our clothes at all, and it will be our business here to endeavour to discriminate carefully between these different insects.

The term "moth" itself even is but a vague one, for it is the only popular designation for a great variety of insects, differing considerably in structure and habits;

and to get a clear and accurate notion of those that inhabit our houses, and of their relations to one another, and to the other members of the group, it will be necessary first to say a few words about the order Lepidoptera in general.

The word Lepidoptera means "scale wings," the scales being that mealy powder which constitutes the coloration and pattern of the wings above and below, and which, in one form or other, is found in all species of the order, and may be regarded as characteristic. Now, in the first place, this large order may, for convenience sake, be roughly, though not very scientifically, divided into two great groups, which are known as the Macro-Lepidoptera and the Micro-Lepidoptera, *i.e.*, the "great" and "small" Lepidoptera. For brevity's sake, these long names are usually curtailed to Macros and Micros respectively. In the former group are included the butterflies, and the majority of the more conspicuous and familiar of the insects called moths—all those insects, in fact, which are sought after so eagerly by the majority of "butterfly catchers." Most of them are of tolerably imposing proportions. The latter group, on the other hand, few people, except those who specially study them, know or care anything about; the reason for this neglect being merely the small size of the majority. To be small is often to be despised, and so the Micros get scant attention, even from professed collectors. Yet it is to these despised Micros that our household moths belong, so that, economically at least, some of them are of considerable importance, and ought to be of corresponding interest.

A few of the Macros often choose our houses to hibernate in, but the members of this group do not, as a rule, court our society. The chief inducements for them to

enter our dwellings are an open window and a brightly shining lamp within, and then in suitable localities they will enter in great numbers, and sacrifice themselves on the funeral pyre. But these are, of course, but chance visitors; and none of the Macros can be regarded as permanent residents with us, propagating themselves as the Micros do, generation after generation, without ever visiting the outer world.

The Micro-Lepidoptera are subdivided into some five or six very distinct groups, to two only of which, however, our strictly household species belong; these two are called the Pyrales and the Tineæ. The former of these, which are placed at the head of the Micros, are amongst the largest of that group, most of them, indeed, being (notwithstanding the names) larger than the smallest of the Macros; and they can usually be readily recognised by their rather pointed wings and their long slender bodies and legs. To this group we must refer the household species known as the Meal Moths, and the Tabby, or Grease Moth. The Tineæ, which may be regarded as some of the lowest of the order, are a very large group of exceedingly varied and interesting habits, and remarkable as containing the smallest of all Lepidoptera. They usually have long narrow wings, edged with deep fringes; and to them belong the true clothes moths, together with several other insects that make themselves obnoxious to the careful housekeeper in other ways than by attacking furs and woollen garments.

The Tineæ, as containing the more familiar insects, may profitably first occupy our attention. This section numbers about seven hundred British species, and our household pests belong to several genera scattered throughout this host. The clothes moths, however, are all members of one genus, *Tinea*, which contains about

thirty British species, of which only a very few trouble us indoors; the rest feed upon lichens, bark, &c., and are therefore found in the open country. The word Tinea is the Latin name for the caterpillar of a clothes moth; in other words, the Romans applied this name to any grub-like insect that damaged clothes, &c., whatever, according to our modern notions, the species might be. Pliny speaks of "a certain Tinea, which is capable of hanging by a thread, or is clad in a jacket, gradually forming for itself its own garment, like a snail its shell, and when this is taken from it it immediately dies; but when its garment has reached its proper dimensions, it changes into a chrysalis, from which, at the proper time, a moth issues." It was natural, therefore, that this term should be adopted by modern naturalists as the generic name for the insects that possess the above-mentioned habits; and it is from this genus *Tinea* that the whole section derives the name Tineæ or Tineina, though it is far from being implied by this that the whole group are the foes of textile fabrics. The word, therefore, has nothing to do with our English word "tiny," though it so happens that members of this group are the tiniest of the whole order.

At least four species of the genus *Tinea* are included under the general name clothes-moth, *i.e.*, as attacking some kind or other of animal fabric. They are *T. pellionella*, *biselliella*, *tapetzella*, and *rusticella*. As the habits of these are somewhat different, it will be necessary to treat of the species separately.

And first as to *T. pellionella*. This is a little creature about half-an-inch in expanse of wings. Its fore wings are of a shining greyish yellow colour, with three indistinct brownish spots in the middle, and the hind wings are whitish grey. It is an abundant species in

houses, and may be found at any time between January and October, though most abundantly in the early summer months. Of course the moth itself is innocent enough; it is in the larval state that it does all the damage to clothes, furs, feathers, &c. The larva is a tiny caterpillar, dull whitish, with a reddish brown head. It is remarkable as being the only one of our four clothes moths that makes a tunic or movable case for itself, protected by which it roams in search of congenial food over our stores of unused and undisturbed garments. Muffs, tippets, and other fur garments it particularly delights in, and many are the valuable furs it has altogether ruined, not so much by the actual quantity of hair devoured, as by the amount it has snipped off and wasted.

The case is most ingeniously constructed; it is made of two materials, an outer layer of fragments of the fabrics that have formed the little creature's food, and an inner layer of silk, which forms a beautifully soft and smooth lining, and is secreted by the caterpillar itself in a manner similar to that in which the silkworm forms its well-known cocoons. It is nearly cylindrical in form, but of slightly larger diameter across the middle, and a little flattened above, and is open at both ends; when crawling or feeding, the little inhabitant thrusts out of one end its head and the three segments of the body behind it, these being the ones that carry the three pairs of legs by which locomotion is effected. As it proceeds on its way it keeps this anterior part of the body exserted, and holding on to the silken lining of its case by its claspers, which are situated towards the other end of the body, drags its house along with it. If danger menaces, it retires completely into its case. The cases are of course very varied in appearance; from the

method of their construction it is manifest that their colour will depend upon that of the material upon which the insect has been feeding, and by judicious variations of its dietary the little tailor can be induced to form cases of all conceivable tints, or mixtures of such. The method employed for adapting the case to the needs of the growing caterpillar is truly marvellous. It is obvious that two kinds of enlargement will be necessary: with the growing stature of the larva the case will need elongation, but it will require an increase of circumference as well; and though the meeting of the former demand presents no difficulty nor necessitates the exercise of much sagacity in the device of a method, the latter might well be the subject of considerable perplexity, and one is scarcely prepared for the extreme ingenuity manifested by the little creature in meeting the difficulty. When it finds its quarters becoming too strait it slits up the case on one side for half its length by means of its scissor-like jaws, and fills up a certain space between the severed edges with the same materials as compose the rest of the case. This done, a similar slit is made, say, at the other end, and the like process gone through again. Though the circumference is now increased throughout, this is not the end of the operation, for the new pieces having been let in only on one side, the case thereby becomes a little unsymmetrical; therefore, to restore the symmetry of its form, two precisely similar operations are carried out on the other side, so that to complete the process no less than four slits have to be made—two at each end—and to be successively filled up with the usual materials. It would appear, however, from the observations of Réaumur, that the insect does not always observe the same order in making these slits, but may vary the order indefinitely.

To lengthen the case all that is necessary is to add successive rings of silk and woollen fibres to the ends; but even in this simple operation there is a choice of methods, for the addition might be made at one end only or at both. The latter device is the one adopted. First of all a ring of new material is added at one end, to effect which the grub does not need to leave its tunic, the whole operation being able to be performed from the inside; a layer of silk is spun out in the form of a continuous thread, and then a number of tiny fillets of the woollen fabric, or fur, are attached to its outer surface by other silken threads. This done, the caterpillar, still without quitting its shelter, rapidly reverses its position, bringing its head into the position previously occupied by its tail. The extreme flexibility of its body, and the rather wider diameter of the case in the centre, enable it to do this very quickly; then the same addition of a ring of felt is carried out at the tail end, and in this way the case is elongated equally at the two ends, and what was originally the middle always remains such, and therefore the oldest part is always to be found in the centre, and the newest at the ends.

When the grub is full fed, it must set its house in order and prepare for the helpless condition which precedes its final metamorphosis. The chrysalis state is assumed inside the case, the caterpillar becoming, by throwing off its last larval skin, a little yellowish-brown helpless thing, similar in form to the well-known chrysalis of the larger moths. Now a danger has to be guarded against: the insect has to remain some weeks in this state of inactivity, and if the case with its precious freight were simply left lying on the cloth as usual, any moving of the latter might cause the little bundle to roll off and fall, no one knows whither, and

into one knows not what perils. To guard against such a catastrophe, the caterpillar, when it feels the inward promptings which are prophetic of its approaching change, spins some fine silken threads from the ends of the case, and attaches them at their outer extremity to the cloth on which it has been feeding, thus, as it were, casting many anchors out of both bow and stern of its little boat. Its fate is in this way linked with that of the larger object, and a much greater degree of security is thus ensured. Very frequently, however, it altogether forsakes the cloth, and chooses some retired corner or crevice in which to anchor its little craft. Thus all through the three weeks of waiting for its wings it lies in its case, like a mummy in its sarcophagus.

At length the time arrives for the final change. The chrysalis, by the aid of sundry little spines arranged in transverse rows along its back, one row on each segment, works itself along till it reaches the end of the case, and then the imprisoned moth, bursting its chitinous covering at the head, gradually extricates itself from its cerements, which it leaves half projecting from the now useless sarcophagus. The cast chrysalis-case forms a very pretty microscopic object; it is almost transparent, slightly tinged with yellowish brown, and shows distinct cases for the antennæ, which clearly present slight constrictions corresponding to the multitude of joints of which the organ itself was composed. It also very plainly shows the hooks along the back, and those on the terminal segment are seen to be the largest and most powerful. On its first exclusion from the chrysalis, the moth's wings are very small and soft, but after a while they expand until they have reached their normal dimensions, and acquired their normal consistency.

Now the little being is ready for the fulfilment of its

mission, the propagation of its species. Its methods of locomotion are twofold: with its four glossy and beautifully fringed wings it can fly tolerably well; but with its six long-jointed legs it can also run rapidly, carrying its wings close alongside its body, and vibrating its antennæ with an incessant tremor indicative of the excitement which now thrills through its little frame. It needs no food, and indeed there is probably nothing within reach that could serve it as such; for the gross aliment which delighted it when a grovelling grub, possesses no charms for it in its higher state of existence; and indeed, were its tastes to tend in that direction, it could not gratify them, for, like the rest of its order, it has no jaws wherewith to reduce the tough fibres of cloth; and even the usual flexible maxillæ, the two long coils which form the sucking apparatus of moths for imbibing honey, are present only in a rudimentary condition, as is the case throughout the genus *Tinea.* Its sole business, therefore, is to get mated, lay its eggs, and die.

As might be expected, the eggs are extremely minute, and they are carefully deposited by the mother on the cloth, or in crevices and corners close to a supply of food. The young grubs hatched from these soon manifest their tailoring propensities, but they seem, at this early stage, to prefer secondhand garments, or rather shoddy, to an entirely new "rig out." In other words, they attack the old cases of their progenitors, which are sure to be lying about in plenty, and by cutting up these larger garments, manage to make some respectable coverings for their own tiny forms. The filaments of wool and fur which have been submitted to the action of the more powerful jaws of their adult ancestors are in a more manageable condition for the weaker weapons of the

juveniles than would be those of cloth that had never undergone such a preparatory process.

Tinea pellionella is one of the commonest and most destructive of our clothes moths, and is especially partial to furs and feathers. Its attachment to the former is indicated in its name, which is derived from the Latin *pellio*, a "furrier." It is sometimes, therefore, called the fur moth. Its larva has also been known to feed on cobwebs.

It now remains to consider the other members of the genus *Tinea* to which the epithet clothes moth is applicable. And first as to *T. bisselliella*. This is a little creature, something like *pellionella*, but usually rather larger and with shining ochreous fore-wings, which are perfectly devoid of spots; the hind-wings are paler, and the head reddish. Its caterpillar feeds upon various animal substances, such as hair, feathers, wool, &c., and so may occasionally be found in the linings of sofas and chairs, and in mattresses. It is an abundant insect, and its habits are similar to those of the before-mentioned species, but there is this difference, that the present insect does not, when a caterpillar, weave for itself a coat in which to go on its travels. At the commencement of its larval life it is said to feed without any covering by way of protection; but after a while it finds the necessity of preserving its delicate body from the attacks of its somewhat ill-tempered and aggressive companions, if from nothing else, and therefore constructs a kind of tubular tunnel in which to take shelter. This, however, is fixed to some support, and is thus a shed rather than a garment. It is in this run, too, that the change to the chrysalis takes place; but then the ends are closed up, and the dormant insect is

thus secured from molestation during the period of its seclusion.

Even at this stage of its life it is a lively little being, any disturbance of its retreat being resented by petulant wrigglings of its brown mummy-like form. When the time for its final change arrives, it shifts itself along to the entrance of the cocoon by means of tiny hooks on its back, and then works its way out of its pupa case, which it leaves projecting from the end of the cocoon. The larvæ may be found in our houses from February to September inclusive, and the moths from April to November.

The next species is *T. tapetzella* (Fig. 29). This is considerably larger than the two preceding, and very different from them in coloration, though sufficiently similar in shape to show that it should be referred to the same genus. When the wings are fully spread, the moth has an expanse of three-quarters of an inch, and it may very easily be recognised by the startling contrast in the distribution of its colours. The fore-wings are black over their basal third part, and then over the rest of their area creamy white, slightly mottled with darker, especially at the tip. The hind-wings are shining brownish-grey, and have long fringes. When the wings are closed, they are laid close alongside the body, and then, of course, no trace of the hind pair is seen. We have simply a long narrow object with the front part black and the hinder white.

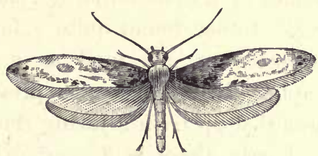


FIG. 29.—Tinea tapetzella.

This insect, in its larval condition, delights in coarser food than its predecessors, and devours with avidity such

fare as carpets, horse-cloths, &c. The thickness and more substantial character of this food affords the grubs protection also, and renders the construction of a separate case unnecessary. As they burrow into the cloth, it is thick enough to conceal them, and they, therefore, only care to line their burrows with silk. In these tunnels they can reside and feed quite secure from observation. This insect is sometimes called the "tapestry moth," from the fact of its depredations occurring chiefly in such materials; the linings of carriages, too, are sometimes destroyed by it. The caterpillar may be found in April and May, and the moth in June and July. From its habits one may easily gather that it is less frequently met with in the house than in outbuildings, such as stables, coach-houses, &c. I once found quite a family of them in a piece of carpet that was used as a bandage round a young sapling in a garden to prevent the cord by which it was tied up from injuring the bark.

Lastly, there is *T. rusticella.* This is less strictly a clothes moth than the others; it seems to be in no way particular as to the exact character of its diet, provided it be of an animal nature, and sufficiently dry, and in consequence it has been found in the most unlikely places. For instance, Mr. C. G. Barrett one winter collected a number of old nests belonging to chaffinches and other birds of that sort—nests that are largely composed of wool and hair—and on keeping them till the summer he obtained from them large numbers of *Tineæ*, the larvæ of which had been feeding on the materials of which the nests were composed; and amongst these were some specimens of the above insect. Again, it was found by Mr. C. Eales in a more unsavoury locality still. He one day came across the dried-up corpse of a

cat, and observing that it contained larvæ and pupæ of some moths, he kept it till the perfect insects appeared. Many of these turned out to be *T. rusticella.* In its natural state, therefore, this insect is clearly a devourer of animal refuse; in fact, one of nature's most useful scavengers. And if we introduce animal matters, though of far less objectionable character than these, into our houses, we need not be surprised that sometimes the scavenger follows them, intent upon the fulfilment of its natural function.

The caterpillar is, as usual, a whitish creature with a brown head. The moth, which is about the size of *T. biselliella*, is dark greyish-brown on its fore-wings, slightly tinged with purplish and minutely speckled with yellowish dots. It has also a pale transparent spot on the disc of the wing before the middle, and another similar but smaller one at the outermost lower angle of the wing.

Various methods have been suggested for getting rid of these pests; this, however, is hardly the place for discussing the merits of rival insecticides. But there is one ingenious method which, if not very practicable, is yet so interesting that it must receive a passing notice. It is well known that silkworms are a prey to a certain disease called "muscardine," which arises from the growth of a parasitic fungus. The idea occurred to Balbiani, that if the larvæ of clothes moths could be inoculated with this disease, the result would be similar to what it was amongst the silkworms: their numbers would be rapidly diminished, and a benefit would thus be conferred upon mankind. He accordingly reduced the remains of some "muscardined" silkworms to a powder, and laid his trap by sprinkling this bait over clothes infested with the destructive larvæ. The grubs

ate of the fatal meal, developed the disease, and miserably perished. The powder, however, was found to lose its efficacy to some extent if kept for any length of time.

These are all the insects that can fairly be called "clothes moths;" but there are several other small moths that occur in our houses, and, being general feeders, are destructive in other ways, though they are generally credited with designs upon our woollen fabrics. Some of these belong to the same extensive genus as the clothes moths proper, *e.g.*, *Tinea ferruginella* (very similar to *rusticella*, but smaller), *fuscipunctella* (also somewhat similar, but without the transparent spot), *misella* (yellowish-brown, with paler markings, and two dark dots), and *nigripunctella* (yellowish, with several blackish spots). Some of these occur not unfrequently, but others are rare.

But there are two insects which greatly exceed in numbers both these and most other household species, and are often more abundant and universally distributed than the clothes moths themselves. They are *Endrosis fenestrella* and *Œcophora pseudo-spretella*, both representatives of a new and very extensive family of *Tineæ*, the *Gelechidæ*. A glance is sufficient to show this; for, first, in rest, the wings lie flat along the back, instead of by the sides, as in the *Tineidæ;* secondly, a hand-lens shows that the head, instead of being crowned with the erect, hair-like plumes of a Tineid, is covered, at any rate in front, with broad, flat-lying scales, which suggest the idea of their having been brushed over the forehead, like the "fringe" of a modern English female; and, thirdly, there is a pair of enormously large curved palpi, much longer than those of the *Tineidæ*, pointing upwards from beneath the head, like a pair of miniature bull's horns.

The former of these insects (Fig. 30) is literally ubiquitous. From appearing usually on windows, it has received the name *fenestrella*, or "window moth," but it has also been called *lacteella*, or "milk moth," in consequence of being so frequently found drowned in the contents of milk-jugs.

FIG. 30.—Endrosis fenestrella.

The water-jugs and basins in our bedrooms also often testify to similar fatalities. It is really a very pretty little creature, and, if only it were rare, would be highly prized on account of its beauty; but being so abundant, and a "moth" to boot, its fair exterior goes for nothing, and it is only considered a nuisance. It has brownish fore-wings, speckled with darker, but its head and thorax are of a pure snow-white. This description is quite sufficient to enable it to be recognised, for there is no other moth like it. It is a larger insect than most of the preceding; and the wings, when fully spread, stretch about two-thirds of an inch. Its white head, which is an exquisite object for a low power of the microscope, renders it easily seen, and in consequence it has often to pay the penalty of death for crimes it has never committed. The finger of the careful housekeeper often comes down upon it with vengeance, treating it as a devourer of woollen goods, when the real culprits—such insignificant creatures as *T. pellionella* and *biselliella*—by their smaller size and obscure appearance, escape notice. It is, in fact, not a clothes eater. Its larva feeds upon all sorts of waste substances, especially those of a vegetable nature, and thus, no doubt, often clears up for us a good deal of rubbish out of odd corners. It may be found all the year round, and probably there

is scarcely a house anywhere of which it is not an inhabitant.

Though the presence of the window-moth in our houses may be condoned, the same cannot be said of its near ally, the detestable pest *Œcophora pseudo-spretella.* This is one of the most destructive insects imaginable, and is apparently a perfectly general feeder; nothing that is in the smallest degree edible comes amiss to it. It is rather larger than *Endrosis fenestrella*, of a pale brown colour, more or less completely mottled over with dark brown and with three very deep brown spots, two before the middle of the wing, placed one above the other, like a colon, and one beyond the middle. The distinctness of these spots depends upon the intensity of the ground colour of the wings, which varies a good deal. The hind-wings are paler, without markings, and, as usual, have long fringes. When in good condition, which is not likely to be the case except just after emergence from the pupa, the fore-wings are shiny. They are placed in a flat position over the back, and thus cause the insect to appear larger than a *Tinea* of the same size would. The moth is fond of concealment, and often hides amongst the substances that have suffered from its depredations. When disturbed, it runs rather than flies, and that very rapidly, at once seeking shelter again. To pursue it with one's fingers is no easy task; it is so rapid in its movements and so slippery when touched, in consequence of the glossiness of its scales, that the pursuit is apt to try both patience and temper of pursuer.

The caterpillar is a whitish creature with a brown head, of an active habit, but concealing itself most effectually by spinning together quantities of the material it happens to be feeding upon. It does not

take the trouble to bite off neat pieces of this material, and weave them carefully and deftly together, as the clothes moths would do, but seizes hold of anything near, whatever its size, and attaches it as it is by one of its ends, so that the pile seems little more than an accidental heap. Under this it can feed at its ease. But a keen eye will soon detect traces of its presence, in the shape of pellets of excrement thrust out from the end of its tunnel. It is particularly fond of invading an entomologist's store of insects, and if he be by any means careless enough to grant it a footing, he will find immense damage done before he suspects anything, and also find that his little foes are very difficult of eradication. The ravages in such cases are really very cleverly concealed, *e.g.*, the unfortunate collector, noticing one of his larger moths, say, with its wings drooping apparently a little more than usual, essays to remove the specimen with a view to discovering the cause, when he finds that, as he pulls out the pin on which it is impaled, he removes no more than a mere shell of the body, and leaves the wings attached to the bottom of the box; *pseudo-spretella* has been at work, and has cleverly fastened down the wings of the moth, but in such a way as hardly to disturb their position, and then, using them as a roof, has proceeded to scoop out the contents of the body, being still careful to leave the skin entire, so that, until the tug at the pin reveals to the chagrined entomologist the utter destruction of his specimen, it looks almost as perfect as ever.

From this habit of concealment, practised by both larvæ and perfect insects, it often happens that vast damage is done before the presence of the destroyer is suspected, and in any case the damage is sure to be great, so much more being spoilt by being woven into

the roof of the shed than is really destroyed by being eaten. Mr. C. S. Gregson speaks of tons of rice in a warehouse having been destroyed by this insect. Each caterpillar had spun together six or eight rice grains, and they thus made numbers of little bundles of rice, which they used both as shelters and as food. The same observer speaks of having been informed that some small caterpillars were doing great damage amongst the stores of sweeping brooms belonging to one of the Local Government Boards in Liverpool. On receiving specimens of the damaged articles, he found that they were ling besoms (brooms made of heather or ling), and that the destroyer was none other than *pseudo-spretella*, which, notwithstanding that all it had to live upon was dry heather brooms, was nevertheless more fat and flourishing than usual.

The larva of this insect is a winter feeder, and may be found in the early months of the year, the moth appearing in July and August.

A very near relative of these two insects, called *Œcogenia Kindermanniella*, is sometimes found in houses, especially near London. It is smaller than either of its allies, and is a very pretty insect, having the narrow fore-wings dark purplish-brown, with three broad pale yellow patches.

CHAPTER VIII.

MEAL AND TABBY MOTHS.

WE may occasionally see perched here and there about our houses, especially in the kitchen regions, little *triangular* moths, of a considerably more robust build than the insignificant little marauders referred to in our last chapter, but still of no very great size. They are members of that exceedingly curious group of moths called the "Pyrales," a group not very largely represented in the British Isles; several of the species, however, are amongst our very commonest insects. All the members of this section have the fore-wings rather narrow, but the hind pair broad and ample; the latter have to be folded lengthwise when closed, in order to allow the narrower fore-pair to cover them, and so, by the close apposition of their edges, to give the insect, when it takes up its position of rest, the shape of an isosceles triangle. The body is narrow, rather long, and tapering almost to a point—a characteristic which at once distinguishes this group from the common Noctuæ, or full-bodied moths; the legs, too, are long and slender, and the antennæ are usually delicate and thread-like. In many cases the wings are very shiny, and even iridescent, and one family, in consequence of their delicate pearly lustre, are popularly called the "Pearls." Some of the Pyrales are exceedingly handsome in coloration, being resplendent with crimson and golden yellow,

or richly adorned with the deepest velvety black, relieved by spots and streaks of silvery white; but, as usual, the majority are more soberly clad in drabs, greys, and browns.

To the ordinary observer, no doubt the most familiar species is the "meal-moth," *Pyralis farinalis* (Fig. 31). This is a very pretty little insect, measuring about an inch in expanse of wings, though specimens are frequently met with considerably smaller. The actual size is largely determined by the amount and character of the food that was available to the insect in its immature stages. If food is scarce or of an inferior quality, the moth becomes small and stunted; but if rich and plentiful, a superior size and more sleek appearance is sure to attest the fact. The dark patches at the base and apex of the fore-wings are reddish-grey, the colour being richest towards the upper edge of the wing. Bounding the basal patch on its outer side and the marginal one on its inner edge are two exquisitely delicate wavy white lines, and then all the space between these is of a rich yellowish-grey, slightly clouded below with darker. The hind-wings are grey, and are crossed by two wavy white lines, which appear like feebler continuations of those on the fore-wings, and a row of distinct black dots at the inner edge of the marginal fringe gives a pretty chequered appearance, and relieves the monotony of the ground colour.

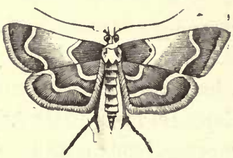


FIG. 31.—Meal Moth.

The caterpillar is a pale, uninteresting-looking creature, with reddish-brown head, and a hard, pale, reddish-brown plate just behind the head, and another at the other end of the body. In its gastronomic relations it is specially

attached to the cereals, the produce of which it will eat in any condition, whether as corn, flour, meal, bran, or even straw. It has also been known to feed on clover. The moth appears during the summer months, and its presence in houses is most to be expected when the flour-box is kept constantly well stored, or better, when a sack of flour is kept. Hence such institutions as workhouses, hospitals, asylums, &c., where large stores of farinaceous substances are necessarily kept, may be expected to produce it more abundantly than ordinary houses. For this reason also it occurs in flour-mills, barns, granaries, and stables, and in bakers' shops, and, indeed, it may be expected to turn up wherever its food is housed in quantity.

For example, a certain French entomologist found his house infested with the insect, and for a long time could not discover whence they came. At last he traced them to a large box of bran on his neighbour's premises. Here they had bred in hundreds, and then had entered his house by the open window. It has even been met with in a coal-mine in Yorkshire more than a quarter of a mile underground. An entomologist, on visiting the colliery, saw some of the moths flying about in the workings, and quantities of the remains of others on the cobwebs with which the place abounded, so that the species was evidently well established there. It had, no doubt, been introduced with the oats for the horses employed below ground.

The caterpillar of this moth is not nearly so easy to find as the perfect insect. The latter delights to perch on walls, and may sometimes be seen in scores, boldly sitting in perfectly exposed situations on the walls of a flour-mill. But the caterpillar loves retirement, and this alone, apart from its unattractive appearance, will account for the fact that its habits remained very

imperfectly known to entomologists long after the moth had become a most familiar insect. The caterpillar constructs long tubes composed of particles of dust and flour or meal, or whatever its food happens to be, spun toughly together with silk of its own manufacture; and, protected by these, it easily pursues its depredations without being discovered. But though it may thus escape the vigilance of human eyes, it cannot manage to elude the penetration of the maternal instinct of the ichneumon-flies, which are ever on the watch for the well-nourished bodies of caterpillars in which to deposit their own eggs; and so even this well-concealed larva has sometimes to succumb to the attacks of *Exochus mansuetor*, an ichneumon-fly whose maggotlike offspring devour its very vitals. The life of most caterpillars extends over only a few months, or even weeks, but the caterpillar of the meal moth is blessed with greater longevity, for, being hatched in the autumn, it survives the snows of two winters, and does not become a perfect insect till the summer of the second year. It spins a tough white silken cocoon, which fits closely upon the glossy chrysalis within.

Two other members of this genus are well-known British insects, though they are not to be regarded as house-frequenters. One of them, *P. glaucinalis*, usually about the same size as the meal moth, or a trifle larger, has glossy, dark, reddish-grey fore-wings, crossed by two delicate yellow lines; the other, *P. costalis*, is much smaller, and is one of the most exquisitely coloured insects we have. It is popularly known as the "Gold Fringe," because the marginal fringes of all the wings are bright golden yellow, a most unusual style of ornamentation. The ground colour of the wings is a delicate pink, which, especially in the fore pair, is more or less

suffused with glossy grey; on the front margin of the same pair there are also two large yellow blotches, which towards the middle of the wing suddenly thin away into tiny golden threads, and thus finish their course to the opposite edge. Anything more charming than this little gem, when freshly disclosed from the pupa, can scarcely be imagined, and words seem too tame to do justice to its glories. It is not so common as the meal moth, and seems chiefly to frequent gardens.

With the meal moth one always mentally associates another common insect called the "Tabby" or "Grease Moth" (Fig. 32). Though not belonging to the genus *Pyralis*, it is nearly related thereto, and exhibits kindred habits in its earlier stages, and is, moreover, a house frequenter. It is scientifically known as *Aglossa pinguinalis*. It is considerably larger than its cousin of the meal-tub, often reaching an expanse of an inch and a half; but it is far less attractive in appearance, being merely dark greyish-brown, with the fore-wings crossed by zigzag blackish lines, suggestive of the markings on the sides of a tabby cat, whence one of its popular names.

FIG. 32.—Grease Moth or Tabby Moth.

The caterpillar begins life as a minute, pale, flesh-coloured grub, but as it grows its colour deepens, until at last, when full fed, it becomes quite black. Like that of *P. farinalis*, it constructs silken tubes in which it obstinately remains concealed till full-fed, living in almost total darkness. It is to be sought for in barns, stables, and outhouses, amongst the accumulations of

vegetable rubbish that abound in the corners of such places. The rubbish serves it both as food and as materials for strengthening the walls of its tubes on the outside; on the inside they are smoothly lined with dark grey-brown silk.

The pertinacity with which the larvæ remain in the seclusion of their galleries renders any observations on their habits and life-history a difficult matter, and often information can only be gained at the cost of the lives of some of the specimens, as they are pretty sure to be more or less injured in the endeavour to eject them from their place of shelter.

The popular name "Grease Moth," and the scientific name *pinguinalis* (greasy), both refer to habits with which this species has been credited for the last 150 years, though considerable doubt has during the last few years been thrown upon them. It has usually been stated that the caterpillar feeds on fat, butter, lard, and other greasy matters; but as the creature is of such retiring habits, it was not easy to make reliable observations on the subject in order to test the accuracy of the statement. It seems, however, *à priori* rather unlikely that the food should be of this character, as greasy substances such as those enumerated have an injurious effect on insect life in a way the following considerations will indicate. Insects breathe through their sides, air being admitted through a series of minute openings, the spiracles, which lead into the breathing tubes which run throughout the body; now, if in any way these spiracles should become clogged, the insect would necessarily be suffocated. But if the caterpillar were to be perpetually eating soft oleaginous substances like butter and lard, and thus to be always living in the midst of grease, it is difficult to understand how it could avoid getting its

body in a very oily condition, and nothing would tend more easily and effectually to clog up the spiracles than such a condition. Accordingly, it has been stated that this insect is gifted with a special power of retracting its spiracles and protecting them by folds of its skin; but the evidence for this is not very satisfactory, and the recent and very careful investigations of the late Mr. W. Buckler, who devoted much time to the study of the subject, do not tend to substantiate the statement at all, but seem rather to indicate that the insect has no more power than any other to protect itself from the injurious effects of an oily condition of its skin. Mr. Buckler tried on several occasions to induce a caterpillar to eat butter and lard by putting it with these substances under a large glass, but he says, "In every case it seemed carefully to shun both, and though I contrived once that it should at least walk over some lard, it did so nimbly enough, but could not be induced to walk over it a second time, invariably swerving aside." Nor did greasy cloth present any greater attractions, though the insects fed readily enough on a collection of rubbish which contained husks of wheat and oats, fragments of straw and thatch, and of pods of beans, small seeds of various kinds, short bits of grass and other dried stems, woolly dust, empty pupa skins of small moths, and a quantity of undeterminable chaffy and earthy matter.

A good idea of the mode of life of these insects may be obtained from a description given by Mr. Buckler of a colony he discovered in a stable. They were found in a dark corner between the oat-bin and the wall. There was only a very narrow space between the two, but quantities of grain and chaff, and particles of straw, frequently fell into it when the oat-bin was opened. On the cool and damp floor beneath, the caterpillars had

constructed their tubular galleries, which were perfectly flexible, and readily adapted themselves to any irregularities of the surface. The tubes were covered with fragments of straw and husks, and therefore, on being removed, they looked simply like strings of rubbish held together in some mysterious and invisible manner, so completely were the silken tunnels concealed. The caterpillars made no attempt to resist the forcible deportation of their residences, and took good care to remain indoors until summarily ejected.

In such situations as these the caterpillars live and thrive from September till the following April, spending the coldest parts of the winter, however, in a more or less torpid condition. When the time for pupation arrives, at the beginning of May, they desert their galleries and wander about, seeking a suitable situation for forming the cocoon. Having found one to its taste, the grub proceeds to surround itself loosely with a tough silken cover, taking care to intermix with the silk particles of rubbish such as will render its appearance sufficiently similar to that of its surroundings, and thus serve as an effectual disguise. To the inside of this cocoon the pupa clings by some recurved hooks, with which, like the meal-moth, the tip of its tail is furnished. The moths appear in July and August.

Réaumur has described this insect as making a tube and devouring the leather coverings of books, a species of depredation which was much more practicable in the days when books were always bound in leather than it would be in these modern days of cloth and paper bindings. He also states that he found it eating the dry bodies of dead insects.

There is a smaller species of *Aglossa*, similar in appearance to *A. pinguinalis*, but much less common. It is

called the "Small Tabby" (*A. cuprealis*). It is paler than the common species, especially in the hind wings. Its habits are very similar to those of the insect already described, and it occurs in similar situations, where, like its congener, it feeds on vegetable refuse. This must, however, not be too dry, or the larvæ become smaller and appear half starved. Too much moisture, on the other hand, would generate mildew, which would be equally harmful to health. The duration of the life of this insect is uncertain; sometimes it completes all its changes in a twelvemonth, but more frequently it prolongs them over a period of two years, the excess of time in the latter instance being caused by a longer larval existence, the egg and pupa stages lasting for the same time in both cases.

CHAPTER IX.

THE COMMON COCKROACH.

UNDER this name some may perhaps hardly recognise the insect so well known as a kitchen nuisance, and popularly called a "black beetle." A more inappropriate name than black beetle could hardly be conceived. The epithet "black" is apparently applied in a loose sort of way to indicate merely a dark colour, for, when closely examined, the creature is seen to be really reddish-brown, of a deeper or brighter tinge according to age and sex, only approaching black in the older females, and then merely on the back. Again, in many important structural characteristics, as well as in the nature of the changes it undergoes in the course of its life, it is widely removed from the true beetles. Not but that there *are* black beetles (*Blaps*, &c.) rightly

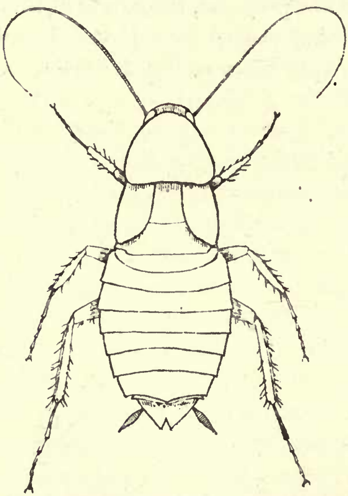


FIG. 33.—The Common Cockroach (*Periplaneta orientalis*), Female.

named, that domicile themselves with man (as we have already seen), lurking in cellars and outhouses, but these are totally different insects from *Periplaneta orientalis* (Fig. 33), the common cockroach, with which we are now concerned, and they never appear in enormous swarms in our kitchens, as the cockroach frequently does.

English soil did not produce this much-maligned insect; it is an immigrant from foreign parts. It is, in fact, not an inhabitant of temperate climes at all, but came originally from the tropical parts of Asia. While importing cargoes of the productions of other countries, we often unwittingly and unintentionally add considerably to our own insular fauna. Probably no shipload of animal or vegetable produce from distant lands starts for our ports without the accompaniment of an assemblage of living creatures, chiefly insects, from the same parts of the globe. Such of these as survive the voyage stand a chance, after unshipment, of becoming naturalised, if only they can speedily find suitable food and a locality which yields a congenial temperature. Amongst such established importations, of which we may now count some dozens of examples, the common cockroach stands pre-eminent as regards both size and numbers, and is probably as cordially hated as any of them except the bed-bug. When the first Asiatic cockroach set foot in Britain, it is impossible to say with certainty, but it was probably not more than about four centuries ago. By the end of the sixteenth century, they had been introduced into the two chief maritime countries of Europe—England and Holland; but we do not get any specific notice of them in zoological literature till near the middle of the seventeenth century, when we read of them as found

in flour mills, wine-cellars, &c., in England. At this early date, it was, of course, only the seaport towns, and principally London, that were frequented by the insect, and it took a long time to spread to inland and country districts—indeed, in all probability, the conquest of England by the cockroach is hardly yet complete. Gilbert White, writing towards the close of the last century, speaks of the cockroach as an unusual insect in the village of Selborne, saying that he had never seen it in his house before; and no doubt there are even now remote country places whither it has not yet penetrated.

Cockroaches are strictly nocturnal in habits, seeking in the daytime the utmost concealment. Hence it happens that they often exist in our houses in multitudes that are perfectly unsuspected until one surprises them in their midnight revels. You visit the kitchen after the lights are out; and as you approach, a faint rustling like the rattling of distant rain, or the pattering of tiny feet, catches your ear. You throw a light on the scene, and on the floor stands revealed a sort of pandemonium, crowded with dark forms hurrying hither and thither, hastening to get into obscure corners away from the glare of the hateful and unexpected light. But when you go in again by daylight they have all disappeared, and no trace of them can be seen. They have packed and squeezed themselves away into niches, cracks, and crevices, under sacks or matting, behind jars or pans, or even under boards, bricks, or stones—anywhere to be out of the light. The flatness of their bodies gives them unusual facilities for thus bestowing themselves.

They have a double reason for frequenting the kitchen premises. First, a tolerably high temperature is

essential to their well-being, as might be expected from importations from the tropics; they cannot stand cold, and much less than the frosts and snows of winter is sufficient to kill them. Therefore they have the good sense to take up their quarters in that part of the house where artificial warmth is most constantly kept up. Then, again, the kitchen regions are the land of plenty, and contain things edible to a greater extent than the rest of the house. Not that they are at all fastidious as regards diet; the most unpromising materials yield them sustenance, and they will absolutely thrive on what might have been supposed to be totally innutritious. They are truly omnivorous: articles of human food, both animal and vegetable, are much to their taste, but they do not stop at these; woollen clothes, newspapers, blacking, ink, leather, and even emery paper will do equally well, and they will even devour their own cast skins, and enjoy a cannibal feast on the corpses of their relations. Professor Moseley records how, during the circumnavigating voyage of H.M.S. *Challenger*, a number of cockroaches, stowaways on the voyage, established themselves in his cabin, and devoured parts of his boots, "nibbling off all the margins of leather projecting beyond the seams on the upper leathers."

The same naturalist gives an amusing account of the attempts he made to rid himself of one particularly unpleasant visitor (apparently a different species from *P. orientalis*, though of similar habits), which seems to have manifested a considerable degree of intelligence. He says, "One huge winged cockroach baffled me in my attempts to get rid of him for a long time. I could not discover his retreat. At night he came out and rested on my book-shelf at the foot of my bed, swaying

his antennæ to and fro, and watching me closely. If I reached out my hand from bed to get a stick, or raised my book to throw it at him, he dropped at once on the deck, and was forthwith out of harm's way. He bothered me much, because, when my light was out, he had a familiar habit of coming to sip the moisture from my face and lips, which was decidedly unpleasant, and awoke me often from a doze. I believe it was with this object that he watched me before I went to sleep. I often had a shot at him with a book or other missile as he sat on the book-shelf, but he always dodged and escaped. His quickness and agility astonished me. At last I triumphed by adopting the advice of Captain Maclear, and shooting him with a pellet of paper from my air-gun, a mode of attack for which he was evidently unprepared."

On board ship cockroaches, of one kind or other, often do much damage. Mr. R. H. Lewis speaks of two kinds of them attacking a cargo of 300 cases of cheeses. Holes had been left in the packages to prevent the cheeses from "sweating," and the cockroaches thus found entrance and damaged them considerably, devouring a great quantity and befouling all. Their disgusting odour, arising from a fœtid fluid poured out from the mouth, renders them far more obnoxious than they would otherwise be, and often causes food to be spoiled by their proximity.

In the perfect condition the male and female cockroaches differ considerably. The males are smaller and less robust than the females; they stand higher on their legs, *i.e.*, do not allow their abdomens to trail along the ground as their partners do, and are furnished with two pairs of wings, the females being apterous, or nearly so. The upper pair of wings, called *elytra*

or *tegmina* (Fig. 34), are rather stiff and horny, and being dark coloured, do not easily show the very peculiar course of the so-called nervures; but the under pair, called specifically *wings*, are membranous and transparent, and the nervures can be easily seen. In repose the wings are folded in half lengthwise, the inner half being bent under the outer, and then itself folded like a fan, and they are then covered by the elytra much as in a beetle, though in that case the folding would be transverse instead of longitudinal, and the elytra would not, as they do here, overlap. When closed, the elytra cover the greater part of the back. The females simply have a rudimentary pair of elytra and no wings at all, and flight is impossible to them.

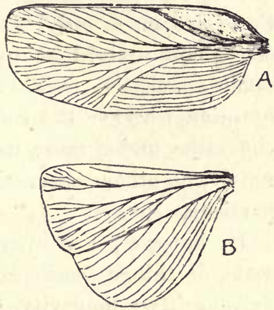


FIG. 34.—A, Elytron; B, Wing of Male Cockroach.

A cockroach issues from the egg, not, like many insects, with a form totally unlike that of its parents, but shaped very similarly to the adult, and differing from that chiefly in its minute size, its pale colour, and the absence of wings. These young cockroaches may often be seen in kitchen hearths in great numbers—little, pale, whitey-brown creatures, running about with extreme agility, and moving their legs so quickly that they seem to skim along or glide over the ground. As they grow, like other insects they cast their skins periodically, after each moult becoming larger and darker. During the first year of its life the young cockroach changes its skin three times—the first immediately after hatching, the second a month later, and

the third not till the end of the year. There would appear to be seven moults in all before the fully developed form is attained, but after the first three, these are made only annually. This, at least, is the conclusion arrived at by Cornelius from observations made on captive cockroaches; but it may be open to question whether the course would have been precisely the same under more natural conditions, and, unfortunately, no other observations have been recorded on this particular species.

If, however, the above results represent the usual state of things, cockroaches are certainly gifted with extraordinary longevity, for their life evidently extends over a period of at least five years. One is accustomed to think of insects as truly ephemeral creatures, and it is probable that the majority of them do not require more than a single twelvemonth to complete their cycle of existence; where the preliminary stages occupy a longer time than this, the species chiefly feed in concealment, as buried in the ground, like the grubs of the cockchafer, or in solid wood, like those of the stag-beetle. The experience of Sir John Lubbock with his ants has, it is true, demonstrated that the life of insects may, under favourable conditions, last much longer than we should have expected. Some of his ants lived with him upwards of eight years; but these were in their perfect condition all that time, and their early life and periods of transformation and growth had been, as usual, rapidly accomplished. Cockroaches, on the other hand, if the above results are to be accepted, take a long time to pass through their introductory stages, but we have no evidence at all as to how long they live after becoming full grown. To so active an insect, the dangers and possible mischances of a long larval life would necessarily

be very numerous, and it is highly probable that great numbers of them would never reach maturity at all. Be that as it may, their swarms are still quite large enough for human comfort. Further observations on their life-history, however, are much to be desired, though no doubt difficult to carry out. A closely allied species, *Blatta germanica*, was studied by Hummel with a very different result, the generations being found to succeed one another with much greater rapidity, and analogy suggests that *P. orientalis*, which is similarly an active, surface-living insect, should run a similar course, and should, at any rate, complete its cycle of changes more rapidly than sluggish grubs which live in solitariness and concealment.

When a cockroach is about to moult, the hard skin splits along the back just behind the head, the split gradually extending throughout the length of the three thoracic segments, and through the opening thus made, the insect slowly and with much exertion extricates itself from its old covering, drawing even its legs and its long tapering whip-like antennæ out of their sheaths, and also leaving behind in the discarded shell parts of its internal anatomy in the shape of the linings of some of its respiratory tubes. The cast skin, which, when thus left, remains clinging to its support just as when the insect was in it, is usually so perfect, except for the slit along the back, that at a distance it might easily be mistaken for a living specimen. Fig. 35 represents the cast skin of a specimen, which, somewhat unusually, performed its moult, fully exposed, half way up the wall of a room where it had been resting for some time in anticipation of the change. Immediately after the moult the insects are of a creamy-white colour, but after the lapse of three or four hours, if exposed to air and

light, they acquire the depth of coloration characteristic of their age, the skin at the same time hardening. As the skin, while soft, is somewhat transparent, the beating of the heart, which, as usual with insects, lies along the middle of the back, just underneath the skin, can be pretty easily observed just after a moult. Cornelius determined in this way that the pulsations were so rapid as eighty per minute. It would hardly be safe, however, to conclude from this that the rate is always so high, for at moulting times the insects are in a very abnormal condition, and their internal economy is much disturbed.

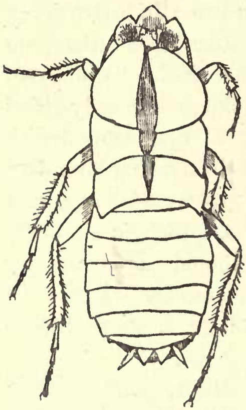


FIG. 35.—Cast Skin of Cockroach.

At the last moult but one the rudiments of wings appear, and the insect is, at this period of its life, sometimes called a "pupa." Many entomologists, however, prefer the term "nymph" for this stage, reserving the name "pupa" for the quiescent condition which precedes the final moult in beetles, bees, butterflies, and flies. No such quiescent condition is observable in the cockroach, and as a nymph it is undistinguishable from the larval or earlier stages, except by the presence of the rudiments of wings, and its life is just as active and rapacious as heretofore. Sometimes the insect is called a nymph throughout the whole of its immature life. At the last moult it appears in its final form and of its final size, the female differing little from its nymph; but the male now acquires its wings, and both are by this

time sexually mature, and possess for the first time the power of procreation.

There are many other insects which develop in a similar way, as, *e.g.*, earwigs, field-bugs and the bed-bug, frog-hoppers and tree-hoppers, lantern-flies, dragon-flies, grasshoppers, locusts, and crickets. All these, together with the cockroaches, as they are active throughout the whole of their life, and pass into their final forms by gradual and slight changes instead of by sudden and strongly marked ones, are said to undergo an "incomplete metamorphosis," and are, for that reason, described as "hemimetabolic." But, on the other hand, the true beetles, together with bees, ants, and wasps, butterflies, moths, flies, and fleas never develop in this way, but always lose their powers of locomotion and eating, and become dormant and inactive as a chrysalis for a certain time immediately before assuming their final shape, and appear in at least three totally distinct forms in the course of their life: such are said to undergo a "complete metamorphosis," and are therefore described as "holometabolic." From this it is evident that the cockroach, the changes in which are so slight as scarcely to deserve the name of metamorphosis at all, is not a beetle—in fact, its nearest allies are the crickets, locusts, and grasshoppers, with which and a number of less familiar insects, such as the curious exotic walking-sticks and walking-leaves, it constitutes the order Orthoptera, a group entirely distinct from the Coleoptera, or true beetles. Of this order, the cockroaches form a numerous and important section, usually called *Blattina* or *Blattidæ*, of which upwards of 800 existing species have already been described.

Some very curious phenomena occur in connection with the formation and deposition of the eggs. These are

laid, not singly, but in purse-like cases containing sixteen each. Cockroaches are not alone in this peculiarity: a somewhat similar method of oviposition is practised by others of the Orthoptera, and the egg-cases of the *Mantidæ*, or praying insects of tropical Africa, in particular are remarkably elegant. The egg-containing case (Fig. 36) is a horny oblong body with rounded ends,

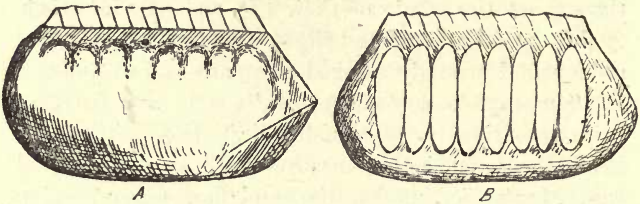


FIG. 36.—Egg-Case of Cockroach. *A*, outside view; *B*, inside view, showing eggs, one side having been removed. (After Miall and Denny.)

and has a longitudinal toothed ridge along the edge, which is uppermost when it is laid. This toothed edge consists of the enlarged borders of a slit which, by the elasticity of the material, is kept closed till pushed open from within. The material of which the case is composed is secreted by a special gland—the *colleterial gland*—consisting of branching tubes, and is poured out in a fluid condition into the cavity from which the case will ultimately issue. It lines the walls of this space, and, hardening in that position, forms a sort of hollow mould of the cavity itself. Eggs are now passed into it one by one, and, as it is gradually filled, its length is increased by fresh additions to its inner end till it is completed.

The question may be asked, why there are always sixteen eggs in each capsule. The answer is simple. The two ovaries each consist of eight tubes, and no more than one egg is ripe in each of these at the same

time, hence sixteen are passed into the capsule, one from each ovarian tube alternately from the two sides. They are regularly placed, like rows of soldiers, eight on each side, with that aspect turned innermost which will ultimately become the under surface of the insect; hence the embryos all face inwards towards the central plane, with their heads towards the serrated edge, while they are arranged, not exactly opposite one another, but alternately, to admit of close packing. When full, the case protrudes from the end of the abdomen of the female, and is carried about by her in this position for about a week, after which it is dropped into a suitable crevice in a warm situation. These dark-brown oblong cases, nearly half-an-inch long, may frequently be found during the summer in kitchen cupboards, &c. The eggs, each of which has a thin but tough and prettily ornamented shell or skin of its own, develop in the cases, and the young, when hatched, issue from the slit at the toothed edge above referred to, having previously, according to some observers, softened the cement with which the opening is closed, by means of a fluid secreted by them—perhaps their saliva. After their exit, the case closes up and looks much as it did before. On hatching, the larvæ are almost colourless, except for their conspicuous black eyes. The female takes no interest in her progeny when once the egg-case is deposited, and the young, when hatched, are left to look after themselves, a business which they perform with entire success.

Periplaneta orientalis is an insect of a comparatively low type of organisation. One evidence of this is seen in its incomplete metamorphosis, and another in the generalised character of the neuration of its wings; a third may be found in the distinct separation and

nearly equal development of the three segments that constitute the thorax; and yet a fourth is supplied by the condition of the mouth organs. To examine these, a little care is requisite. The head can scarcely be seen at all from above, under ordinary circumstances, partly because it is bent underneath at an acute angle to the body, and partly because the greater portion of what would otherwise be visible is concealed by the projecting front of the semicircular shield which forms the roof of the anterior segment of the thorax. If, however, the insect be fixed on its back by a couple of pins thrust through the sides of its thorax, and the head then lifted up and turned back with the point of a pin, and retained in that position by means of two pins crossing one another, the mouth parts will be disclosed and may be examined in detail with a hand lens.

They consist of the usual parts. Taking them in the order in which they are now placed, we find, first, the

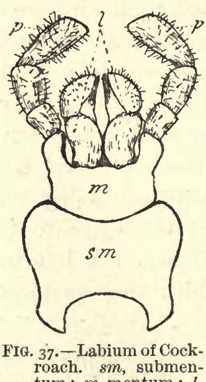


FIG. 37.—Labium of Cockroach. *sm*, submentum; *m*, mentum; *l*, ligula; *p*, labial palpi.

labium, centrally situated, and closing the aperture of the mouth below. By a little manipulation with the point of a pin it may easily be removed entire (Fig. 37), and if then mounted in glycerine, may be examined either with a hand-lens or the compound microscope. It consists of two basal transverse plates, the larger one (*submentum*) behind, and the smaller (*mentum*) in front. To the front of the mentum are attached in the centre two separate organs, called collectively the *ligula;* each is divided longitudinally into two divisions. Outside these two organs are a pair, one on each side, of

freely movable three-jointed appendages beset with hairs (*labial palpi*). We shall recur to the structure of the labium presently; meanwhile we may pass to the next part of the feeding apparatus. This consists of a pair of jointed organs (*maxillæ*), one on each side, clearly revealed by the removal of the labium. One of these may be removed (Fig. 38) and examined in the same way as the labium. It is seen to consist of two basal joints, the *cardo* and the *stipes*, followed by a blade-like piece attached to the end of the stipes, and divided longitudinally into two parts, the inner (*lacinia*), hard, blade-shaped, and beset with stiff bristles along its inner edge, and the outer (*galea*) less hard, and receiving the tip of the lacinia in a groove in itself. Outside this second segment of the jaw, and also attached to the stipes, is a freely movable five-jointed organ, the *maxillary palpus*, set with hairs.

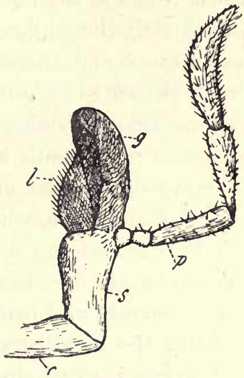


FIG. 38.—Maxilla of Cockroach. *c*, cardo; *s*, stipes; *l*, lacinia; *g*, galea; *p*, palpus.

From this description, taken in conjunction with the figure, it is evident that the structure of a single maxilla is very much like that of each half of the labium; indeed, if we were to imagine the cardo and stipes of each maxilla considerably broadened, and then those of the opposite sides united by their inner edges, we should get an organ on a somewhat larger scale, indeed, but otherwise almost the exact counterpart of the labium. And such, in fact, is the composition of this complex organ, the labium; it consists, namely, of a pair of jaws (*second maxillæ*) fused together by their basal portions,

the united parts constituting the mentum and submentum. But while in the cockroach it is obvious enough that such is the origin of the labium, it is not by any means so easy to make out in more highly specialised insects, as the fusion of parts is in them much more complete, and the whole organ is frequently so greatly modified in form as to entirely obliterate any resemblance to the maxillæ. The cockroach is therefore valuable to the philosophical zoologist, as exhibiting a less altered and therefore more primitive form of this organ than is to be found in the higher orders of insects, and as thus shedding light upon the constitution of a part of the mouth apparatus, which would otherwise be more difficult to understand. The incipient entomologist, therefore, who desires to obtain a sound and practical knowledge of his science, could not do better than take his first lessons in insect anatomy from this very abundant and primitive species.

After the maxillæ succeed the *mandibles*, two broad and strong jaws of simple structure, with toothed inner edges, each capable of moving laterally through an angle of about 30 degrees. These form very efficient biting organs, and are the chief instruments for the division of the food. The whole feeding apparatus, when closed, is partly covered above by a central plate, the *labrum*. The two pairs of palpi are in incessant motion, even when food is not being taken, and seem to be used as tactile organs, to explore the surface over which the insect passes.

The extraordinary agility of cockroaches is matter of frequent comment with every housewife; and in consequence of their speed, and the extreme slipperiness of their smooth and polished skins, they are the most exasperating of insects to endeavour to catch; while, if

one tries to crush them as they run, by bringing some heavy body down upon them, the blow too often descends, much to the mortification of the would-be slaughterer, not on the insect aimed at, but upon the ground considerably in its rear. There is a fussiness and bustle about their movements which is eminently characteristic: it is not merely that much ground is covered in a short time, but also that the legs themselves are moved with remarkable rapidity. You rarely see a cockroach do anything but *run;* it hardly ever condescends to walk, and for this reason it and its associates are called the "cursorial" or running group of the order Orthoptera, while the grasshoppers, our other chief division of the order, which are distinguished by their leaping powers, and could not possibly run, are described as the "saltatorial," or leaping Orthoptera.

And yet, notwithstanding the speed of which the cockroach is capable, there is nothing exceptional in the mechanism of the movements, and the slowest crawling insect moves its six legs by precisely the same means, and in precisely the same order, as this agile creature. We may, therefore, take the structure and method of use of a cockroach's legs as typical of all creeping, walking, and running insects; and there is much in them that will well repay a careful and thoughtful examination. Like those of all other insects, and of centipedes, spiders, scorpions, crabs, and lobsters, and many other allied animals, the legs are composed of a series of pieces jointed together in longitudinal order; and each piece is essentially a hollow tube, the hard and stiff walls of which give the limb its unalterable form, while they furnish support inside to the muscles by which it is moved. In some of the above animals additional firmness and strength is imparted to this hard

covering by the deposition within its substance of mineral salts, especially carbonate of lime; but that is not the case with insects, the hard skin of which owes its strength and power of resistance to the animal substance chitin, which has a chemical composition represented by the formula $C_{15}H_{26}N_2O_{10}$. No greater contrast could be imagined to the vertebrate leg, with its well-nigh solid rods of bone up the centre, and its soft muscles wrapped round the outside of these, than this arthropterous (jointed-footed) limb with its hard tubular envelope, to the inside of which its soft muscular apparatus is fitted.

At the point where the leg is attached to the body, the skin is soft and flexible, whereby alone any motion with regard to the body becomes possible. At this point the limb may be easily detached with a pair of scissors, and we will suppose one of the *hind* pair to have been amputated in this way. Four main divisions to the limb now become apparent (Fig. 39), and in order thoroughly to understand the process of locomotion, it will be necessary to consider these divisions in some detail. First, there is a stout triangular portion, by one edge of which the limb is attached to the body; it is capable chiefly of a backward and forward movement, as will become manifest by working a leg about while it is still attached to the body. This triangular basal joint is called the *coxa*, and in the cockroach is chiefly remarkable for its large size and for the great extent to which it projects from the body. Following the coxa is a longer narrower piece, flattened at the sides, and

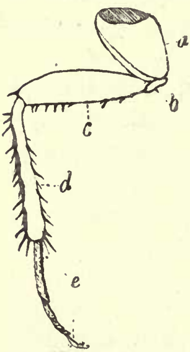


FIG. 39.—Left Hind Leg of Cockroach. *a*, coxa; *b*, trochanter; *c*, femur; *d*, tibia; *e*, tarsus.

furnished with stout spines on its lower edge; this is the *femur* or thigh. It is movable upon the coxa with an up-and-down movement, *i.e.*, in a vertical plane. When the insect is viewed from above, the coxæ are not seen, as they are then concealed by the body, and the legs thus appear to commence with the femora. The femur is succeeded by a longer and narrower straight piece, set with spines on both edges, which is called the *tibia* or shank. It is movable upon the femur in a vertical plane, but in the opposite direction to that of the femur upon the coxa. Finally, the leg terminates in a series of five joints, called collectively the *tarsus*, or foot, of which the one attached to the tibia is by far the longest, and the next three regularly diminish in length; but the last one is longer again, and carries at its extremity a pair of hooked claws. The joints of the tarsus are movable upon one another in the same plane as the tibia and femur, and possess at the same time the power of motion to a slight extent from side to side. These are all the parts of the leg that are obvious at a first glance, but there is still another small joint which a careful examination will detect at the outer extremity of the coxa; it is a tiny triangular piece called the *trochanter*, and has very little freedom of motion. The other two pairs of legs are similarly constituted to the hind pair, the chief differences being in the proportional length of the parts, a matter in which great uniformity is preserved in all specimens.

But though the structure of all six legs is similar, the functions of the three pairs are somewhat different. In running, the first and third leg of one side are moved forward simultaneously with the middle one of the opposite side; then the other three follow for the next step, and so on. There are, therefore, never less than three legs in contact with the ground at the same time,

and the tarsus is the only part that is applied to the ground, the tibia and femur being set at an angle to the tarsus and to one another. Now it is obvious that when the front leg is advanced and placed in position for a step, it is in a state of extension, the thigh being set at an obtuse angle to the shank; but the hind leg, under the same circumstances, is in a state of contraction, the thigh and shank being drawn more closely together. Therefore, when the body is advanced, the front leg is bent up and the hind leg opened out; in other words, the front leg acts in such a way as to pull the body along, the claws at the end of the feet giving secure foothold meanwhile. The hind leg, on the other hand, is not a pulling but a pushing organ, while the middle leg of the opposite side serves chiefly as a support and pivot for the body. The whole of these movements are effected by means of muscles inside the legs, each of which has one end of itself attached to one division of the leg, and the other to the succeeding one. Such, then, is the method of locomotion of the cockroach, and not only of it, but of every creeping, walking, or running six-footed animal. Most swimming and jumping insects, naturally enough, however, adopt a different style, the corresponding legs of the opposite sides being moved simultaneously instead of alternately.

The digestive system of the cockroach (Fig. 40) is very complete, and as there is not much difficulty in its dissection, any one may easily make out its details for himself. The only thing to be borne in mind is that all such delicate dissections as these should be performed under water, *i.e.*, the insect is fastened to a layer of solid paraffin or cork (or any other substance that will receive and hold pins readily), with which the bottom of a shallow dish has been coated, and then water has been poured

over it to the depth of an inch or so. Under these circumstances, when the body is opened, the organs

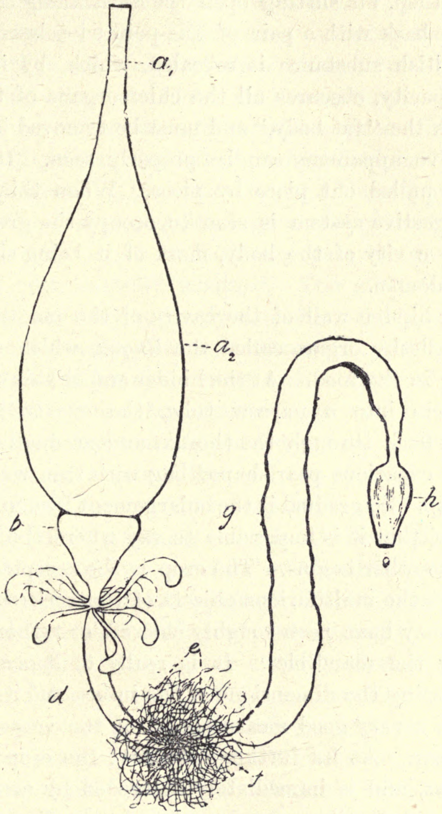


FIG. 40.—Digestive System of Cockroach. a_1, œsophagus; a_2, crop; *b*, gizzard; *c*, hepatic cæca; *d*, mesenteron; *e*, Malpighian tubules; *f*, ileum; *g*, colon; *h*, rectum.

within, being buoyed up by the surrounding liquid, are displayed and rendered distinguishable to a much greater extent than would be possible in the absence

of such a medium. We will suppose the insect to have been pinned down to its support in its natural position; then, on slitting open the skin along the middle of the back with a pair of fine-pointed scissors, a mass of whitish substance is revealed, which, by its extent and opacity, obscures all the chief organs of the body. This is the "fat body," and must be removed before the digestive apparatus can be properly seen. It may be gently pulled out piece by piece. When this is done, the digestive system is seen to occupy the greater part of the cavity of the body, most of it being situated in the abdomen.

The hinder wall of the cavity of the mouth forms a raised fleshy organ, called the *lingua*, which assists in taking in the food. At the hinder end of this the throat contracts into a narrow tube, the *œsophagus*, which passes back through the thorax, and gradually expands into a capacious pear-shaped bag with thin walls, called the *crop*. So gradual is the enlargement from œsophagus to crop, that it is impossible to say where the one ends and the other begins. The crop is the receptacle which receives the multifarious objects of the cockroach's diet, after they have been roughly chewed, or rather chopped up, by the mandibles. It is really of enormous size, considering the dimensions of the insect, and its capacity affords a very good measurement of the voracity of its possessor. At its further extremity the crop suddenly narrows, and is immediately succeeded by another and very much smaller pear-shaped body, set the other way round, *i.e.*, with its large end foremost and narrowing behind. It has thick muscular walls, and is furnished inside with a circle of six large chitinous prominences called teeth, as well as with little cushion-like bodies set with hairs. The whole organ is called the *gizzard*.

The gizzard opens behind into a short narrow tube of about the same diameter as the œsophagus, and called the *mesenteron*, or mid-gut. Where this joins the gizzard, there are eight blind tubes radiating from it, tubes, *i.e.*, that are closed at their outer extremity but open at the other end into the mesenteron. They are called *hepatic cœca*, and secrete a juice which is needed in digestion, and which, when food has to be digested, is forced up into the crop, and there performs that operation, the passage leading into the gizzard being meanwhile closed, that no food may pass the junction till it has been suitably modified. The gizzard would seem to be not very correctly named, as it appears to act more as a strainer than as a triturator. At the end of the mesenteron we again meet with a circle of blind tubes, but these are far more minute and far more numerous than those at its commencement. They are some sixty or more in number, and are arranged in six sets. They are so fine that they look simply like a tangle of the finest gossamer threads. Individually they are very long, and twist about in all directions, and amongst the other organs situated in their neighbourhood. They are called *Malpighian tubules*, and though so fine, are in reality tubes, closed at their outer end, but opening into the intestine. They are excretory in function, and appear to perform the office of kidneys. Succeeding the mesenteron, we get the intestine, which is divisible into three regions. The first is a short narrow tube, called the *ileum;* the second a much longer and broader one, the *colon*, with loose baggy walls, and contracted towards its hinder extremity; and the third a pear-shaped body, with its internal walls set into six prominent ridges or folds; this is called the *rectum.*

The whole alimentary canal, from the commencement

of the œsophagus to the end of the rectum, measures about twice the length of the animal's body. All the earlier part, as far as the end of the gizzard, runs straight through the body without twisting; but the parts after this are more or less twisted about, in order to accommodate their length and bring the rectum to the middle of the hinder end of the body; hence that portion of the canal after the gizzard needs unravelling to display its parts. In the figure it is shown in this extended condition, but in nature the rectum would be situated near to the bundles of Malpighian tubules, and the intestine would be twisted about in that neighbourhood. It is impossible in the figure to show all the windings of the Malpighian tubules; they are not merely clustered about the mesenteron as shown, but their ends are interlaced amongst the breathing tubes and the fat body, and spread all over the abdomen. In all these parts they are bathed by the blood which fills all the cavities of the body, and eliminate from it the nitrogenous waste products, which thus ultimately find their way into the intestine. That part of the alimentary canal extending from the mouth to the end of the gizzard is called the *stomatodœum*, and that from the commencement of the ileum to the end of the rectum the *proctodœum*. Each of these cavities was formed as a gradual growth inwards of a depression of the outer surface of the body; hence each is lined with a continuation of the chitinous skin which invests the body, and this is, therefore, renewed each time the skin is cast. The mesenteron, on the other hand, originated in a different way, and hence is not so lined. The "teeth" of the gizzard are simply extra hard portions of this chitinous lining.

In order to complete the sketch already given of the

digestive system, we have yet to notice some important accessory organs, the salivary glands, which in the cockroach are enormously developed. On opening the body, they may be seen lying along just outside the walls of the crop in its anterior part. Each consists of a pair of white glands (Fig. 41), and a very thin-walled elongated bag or receptacle, quite distinct from these. Each gland, though apparently compact, really consists of a flattened tree-like structure, the foliage portions of which contain the cells which secrete the saliva, while the branches are minute tubes which convey it, when secreted, from the gland. A narrow tube, or "duct," formed by the union of the above branches, receives the salivary fluid from each gland; but the two ducts of each side soon unite into a single one, and the two thus formed again coalesce and form one main central tube lying under the œsophagus.

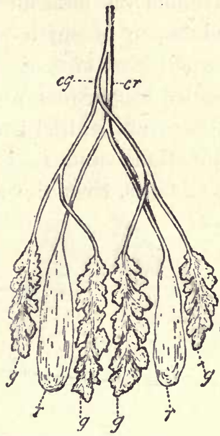


FIG. 41.—Salivary Glands of Cockroach. *g*, glands; *r*, receptacles; *cg*, common duct of glands; *cr*, common duct of receptacles.

Similarly the ducts of the receptacles unite in a single central canal, which receives a little beyond this junction the common duct of the glands, and so finally only one tube remains as the representative of the original six, and this opens into the mouth behind the tongue.

Like other terrestrial insects, a cockroach breathes by taking in air, not through its mouth, but at certain openings in the sides, called spiracles, or *stigmata*. There are ten of these on each side, eight pairs being

situated in the abdomen, and the other two in the thorax. Those belonging to the abdomen are not very easy to detect, as they are small, and all but one pair obscurely situated. The chitinous integument which bounds and determines the form of each segment of the abdomen is not a complete ring round the body, but consists of two distinct parts, a band across the back, called the *tergum*, and another underneath, the *sternum.* These are united towards their edges by a membranous junction; and it is in this, at the junction of the segments, that the stigmata lie, concealed by the overlapping edges of the terga and sterna. Each is an oval aperture situated on the summit of a small conical eminence (Fig. 42), and capable of being closed by an internal valve, whereby dust and other foreign matters are excluded. A large tracheal tube proceeds from each, and very soon begins to subdivide into smaller ones, the ultimate ramifications of which pass to the remotest parts of the body, and even into the jaws, wings, legs, and antennæ. By means of this system of tubes, air is conveyed to all parts of the organism, so that the blood is aërated, not, as in most kinds of animals, by being brought from the body at large and collected in some special organ, such as a lung or a gill, there to come into contact with the air, but by having the air conveyed to it in all parts of the body at once.

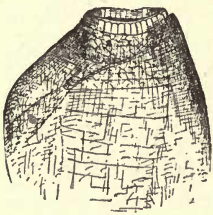


FIG. 42.—Abdominal Spiracle of Cockroach.

The introduction and expulsion of air is, of course, accompanied by movements of the body walls; but these are not very easy to see, as they are but slight in amount. Plateau succeeded in demonstrating their

character and extent by the ingenious method of projecting the form of the body of the living insect on a screen by means of the lantern, and then tracing its outline during inspiration and expiration respectively. In general, an insect at rest performs its respiratory movements with the hinder part of its body, in other words, it pants with its *abdomen*, the movements consisting of an alternate contraction and recovery of shape of that region. Amongst British insects there is perhaps no species in which it is easier to watch these movements than the great green grasshopper, a large locust-like insect, found not unfrequently in some parts of the country. By the contraction of certain abdominal muscles, the upper and lower walls of the abdomen are drawn together to the extent, in the cockroach, of one-eighth of the entire depth of the body, and a compression from side to side takes place at the same time. The tracheal tubes are thus compressed, and air is forced out at the stigmata; on the relaxation of the muscles, the elasticity of the tracheal tubes themselves, resulting from the coiled spiral thread in their interior, then restores the body to its normal form, while air in consequence enters at the stigmata. In the cockroach, the thoracic segments have sufficient mobility to permit of their taking some part in the movements of respiration, even when the insect is at rest, in which respect it differs from most other insects. In order, therefore, clearly to realise how a cockroach breathes, we have to bear in mind that, concurrently with the rise and fall of the body walls, ten little jets of air alternately enter at and issue from as many openings in the insect's sides, the outward-tending jets of course carrying with them the carbonic acid and water vapour produced as the insect discharges its vital functions.

But the respiratory movements above described can scarcely be regarded as providing a complete explanation of the mechanism of breathing, for they would simply have the effect of renewing that portion of the contents of the tracheal tubes which is in the parts nearest the spiracles, and the air in the minute and remote subdivisions of the tracheæ would have no chance of being expelled, and would simply oscillate up and down the tubes, and never reach the outer air at all. How this difficulty is met is not at present altogether clear, but it seems certain that we must look to the principle of gaseous diffusion as at any rate aiding in producing the required result of the penetration of oxygen to the remotest parts of the system, and the corresponding outward passage of the carbonic acid formed. The rate of breathing depends upon a variety of circumstances. It is quickened by whatever increases the general activities of the insect; thus, a swiftly running cockroach breathes more quickly than one at rest; and, again, a well-fed individual is naturally more vigorous and inclined for exertion than a lean and emaciated one, and its respiration becomes in consequence more rapid. Cold, on the other hand, has a benumbing effect, and the rate of breathing therefore falls with the temperature.

The extreme perfection of the respiratory system is closely connected with and correlated to a very rudimentary condition in the circulatory apparatus. As the air is conveyed to every part of the body, and oxygenation can take place anywhere, there would clearly be no object in having any special apparatus for the collection and guidance of the blood. A cockroach has indeed, as already mentioned, a heart, but beyond this it can scarcely be said to possess any

circulatory system. Any one who brings to the examination of a creature such as this the popular conception of what a heart is like, will certainly fail to find anything which bears the remotest resemblance to such conception. There is, in fact, no compact, chambered, fleshy, conical body such as we are familiar with in vertebrate anatomy; the "heart," so called from its function, not its form, is merely an inconspicuous, elongated, soft tube, with sundry openings in its sides through which blood enters it from the body at large. Nor is its position such as might have been anticipated; we must look for it, not towards that side of the body which faces the ground, but on that which is uppermost, for it lies along the whole length of the back, just beneath the skin, in the middle line. Nor, again, does this rudimentary heart communicate with any system of blood-vessels for conducting the blood on its tour round the body; for the blood, on being expelled from the orifice at the extremity of the tube, is simply passed on through the various interstices between the different viscera, until it ultimately finds itself back again at the place it started from. Hence it is manifest that every movement of the body which in any way disturbs the relative position of the internal organs, will assist, to some extent, in urging the blood along its course. Nor, finally, is the blood itself exactly what its name might suggest. If a cockroach is wounded, blood will, of course, issue from the wound, but as it is only a colourless liquid, a little stretch of the imagination is required to realise that it is the true nutrient fluid of the body.

By the dissection which removes the digestive tract, the main part of the nervous system is laid bare. It is constructed similarly to that of the earthworm, and

consists of a chain of nervous centres or ganglia, in pairs, connected with one another by nervous threads (Fig. 43), and extending from one end of the body to the other. The greater part of it lies between the digestive tract and the under surface of the body, and is therefore nearest the ground when the animal walks. Here again, therefore, all preconceived notions gathered from the familiar vertebrates are upset, as we trace the great nerve-centres, not down the back, but in exactly the reverse position. The foremost pair of ganglia, however, which are situated in the head, and have been dignified with the name of "brain," as they send nerves to the sense organs, viz., the eyes and antennæ, lie above the œsophagus, being connected by two thick bands of nervous tissue with the first pair that underlie it, so enclosing that portion of the digestive tract as in a collar. While examining the distended crop as it lies in its natural position, a small nervous ganglion may be observed as a little triangular whitish spot on its upper surface about half-way down its length. From this two nerves pass obliquely backwards towards the hinder part of the crop, while a single one, running forward along the middle line, connects this centre with some small ganglia in the neighbourhood of the brain. This small collection of nerves and ganglia is called the visceral nervous system.

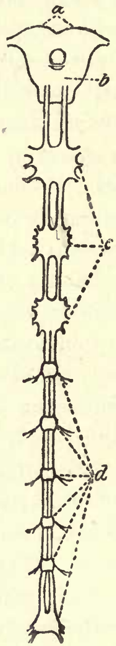


FIG. 43. — Nervous Chain of Cockroach. *a*, supra-œsophageal ganglia; *b*, sub-œsophageal ganglia; *c*, thoracic ganglia; *d*, abdominal ganglia.

Such is the insect which foreign commerce has introduced to our island, and which, by reason of the persistence with which it clings to the fortunes of the human race, has become truly cosmopolitan, and seems to be almost a necessary adjunct of modern civilisation. Nowhere a welcome guest, it yet quietly pushes on its conquests, and even the determined hostility of the tidy housewife does not avail to check its progress. Its nocturnal habits and love of concealment make it a very difficult insect to eradicate when once it has established itself in a house, and it is to be feared that no certain remedy for this nuisance has yet been discovered. Spite of "beetle-traps" and "vermin-powders," it maintains its ground; neither rats, cats, nor hedgehogs (all numbered amongst its foes, and the last especially a greedy devourer of it) are able materially to lessen its numbers. By reason of some subtle superiority, perhaps impossible for our gross senses to perceive, it continues to be victorious over all its enemies, and in the face of all opposition and efforts to exterminate it, still flourishes and continually spreads. It is, indeed, gradually dislodging an old and familiar inhabitant of kitchens, the house-cricket, an insect of very similar habits to itself, and no very distant relation of its own.

P. orientalis is not the only species of cockroach which attaches itself to man. A considerably larger species, *P. Americana*, which is winged in both sexes, has spread a good deal from its native haunts in tropical America, and has effected a lodgment in some places in this country. But for some reason or other, it does not seem likely to displace *orientalis*, a curious fact, inasmuch as it is a stronger insect, and, being gifted with wings in both sexes, might be supposed to have had

better opportunities of establishing itself. It is a common species on board ships. An Australian species also appears to be beginning to spread. Again, *Blatta germanica*, a closely allied form, called in America the "Croton Bug," is known all over the United States, and sometimes gets a footing in Britain. In a baker's shop at Leeds it established itself, and is said to have been introduced by soldiers after the Crimean war, coming with them to the barracks, and being thence conveyed to the bakery in bread baskets. According to Hummel, this species assists its young to escape from the egg-case. He introduced a female into a bottle containing one of the cases; she immediately seized it and slit it open with her jaws, and tore off the enveloping membranes of the contained young.

Besides house cockroaches, we have in this country field cockroaches, *i.e.*, indigenous species that habitually live out in the open and do not attach themselves to mankind. They are smaller than *P. orientalis*, and may be found in sandy places and amongst dead leaves and other vegetable rubbish. They have sufficient superficial resemblance to *P. orientalis* to be recognisable as coming into the same category, although their colour is generally much paler. In addition to these, large numbers of species occur wild in other countries; but why just those particular species mentioned above, and especially *P. orientalis* itself, should have become dependent upon the human race, while so many others have either not attempted to do so, or have not succeeded if they have attempted, is still shrouded in mystery. The chief peculiarity by which *orientalis* is distinguished from its fellows, viz., the apterous condition of the female, seems rather as though it might militate against its chances than favour them.

CHAPTER X.

CRICKETS AND EARWIGS.

Few domestic insects have succeeded in inspiring such widely different sentiments in the minds of their hosts as the house cricket. To most people it is far better known by the evidence of the ears than of the eyes. Its shrill chirping, prognosticatory, according to popular belief, of cheerfulness and plenty, reveals the performer's presence when no trace of its person can be discerned; and like the similar sound made by its near relative, the grasshopper, it is one which there is great difficulty in localising or tracing to its origin. Distinct and intensely penetrating though this "shrilling" is, yet most people find it a perplexing task to decide exactly from what quarter it proceeds. This constitutes an element of mysteriousness, and it is not surprising that the invisible minstrel should have been accredited with occult influences. The feelings with which the sound has been regarded have accordingly varied with the disposition of the hearer, from superstitious reverence to downright dislike and extreme irritation. While to Milton, for example, "the cricket on the hearth" seemed no unsuitable accompaniment of thoughtful solitude, when the devotee of "divinest melancholy" retires to

> "Some still removed place . . .
> Where glowing embers through the room
> Teach light to counterfeit a gloom,"

on Gilbert White, the naturalist of Selborne, the chirping of crickets had quite an opposite effect. Speaking of the field cricket, which is in most respects much like its cousin of the house, he remarks, "Sounds do not always give us pleasure according to their sweetness and melody, nor do harsh sounds always displease. We are more apt to be captivated or disgusted with the associations which they promote than with the notes themselves. Thus the shrilling of the field cricket, though sharp and stridulous, yet marvellously delights some hearers, filling their minds with a train of summer ideas of everything that is rural, verdurous, and joyous."

If poet and naturalist do not agree here, still less are they in accord in other instances; if to the former the cricket is "Little inmate, full of mirth," "Always harbinger of good," one whose song is "soft and sweet" (!), to the latter it is a "garrulous animal," keeping up a "constant din," "a still more annoying insect than the common cockroach, adding an incessant noise to its ravages." And while the simple and easy-going rustic life of olden times might tolerate and even enjoy this incessant clatter, the state of nervous tension at which so much of present-day life is lived will no doubt lead most people to agree with the naturalist here, rather than with the poet, and vote the cricket a household nuisance. The noise upon which such different views have been held is apparently a love-call, and is accordingly produced only by the males, the female crickets being, in fact, through the absence of the requisite machinery for chirping, absolutely dumb. To the cause of the noise we shall recur presently; meanwhile, we may consider the zoological position and the structure of the insect.

As a family, the crickets enjoy a wide distribution

and in this country five species have been met with, though for some reason best known to themselves, only one has domesticated itself. The family is called *Gryllidæ*, and is closely allied to those of the grasshoppers and locusts, forming with them one of the great divisions of the order Orthoptera, viz., that of the "leapers." To another section of the same order, viz., the "runners," it will be remembered, the cockroach belongs. Our English domestic species (Fig. 44) is called *Gryllus domesticus*. At first sight a cricket strikes one as being not unlike a grasshopper in general form, the resemblance being caused chiefly by the great proportionate length and elevated position of the hind legs. In body, however, it is broader and flatter than a grasshopper, and in other respects is sufficiently distinct to be regarded as the type of a different family.

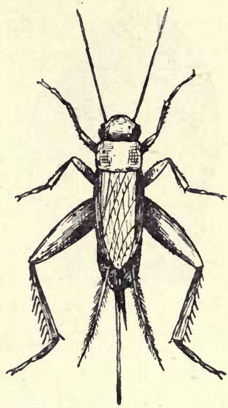


FIG. 44.—House Cricket (*Gryllus domesticus*).

The mouth organs bear a close resemblance to those of the cockroach, as a comparison of the accompanying figures with those on pp. 128, 129 will testify. As one looks in the insect's face, the greater part of the mouth organs is concealed by a not very stout flap, hinged above and shaped like a cheese-cutter; this is the *labrum*, or upper lip. On lifting it, like the visor of a knight's helmet, there is disclosed a pair of stout, dark brown, horny, toothed jaws (*mandibles*) (Fig. 45), which are used not merely to divide the food, but also as excavating implements, to hollow out retreats into which the insects can retire in the daytime or when alarmed. These mandibles

again, when closed, completely cover the rest of the mouth organs; on their removal, the secondary jaws, or *maxillæ*, come into view (Fig. 46); these are very much like the cockroach's, the inner lobe (*lacinia*) being tipped with two sharp teeth, and received for protection's sake into a groove of the outer (*galea*), and they are furnished with a pair of five-jointed palpi. Beneath, or rather behind them, is the *labium*, showing again a similar structure to that of the prototype, and equally obviously composed of a pair of jaws which have coalesced, *i.e.*, have become united into a single organ in their basal portion; this, too, carries a

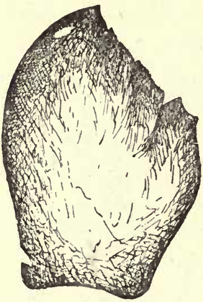


FIG. 45.—Mandible of Cricket.

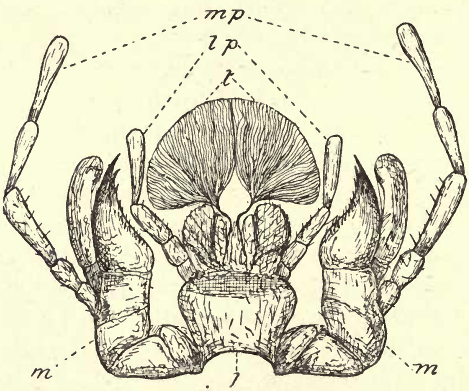


FIG. 46.—Mouth Organs of Cricket. *m*, maxillæ; *mp*, maxillary palpi; *l*, labium; *lp*, labial palpi; *t*, tongue.

pair of palpi. The chief difference between the two insects is to be seen in the appendage to the labium in its centre, which is called the *ligula*, or "tongue." This

is a most marvellous and exquisite structure, and deservedly a great favourite with microscopists. As shown in the figure, it is pressed out of place. On opening the mouth, it will be seen on the floor, rising into a grooved, hollow, fleshy eminence. When flattened out, it is found to be a kidney-shaped, leaf-like expansion, strengthened throughout by radiating fibres of chitinous material, which, when highly magnified, show a beautiful mosaic structure. Kitchen refuse of various kinds constitutes the food of these creatures, and a good deal of moisture as well seems necessary for their well-being. No doubt this curious tongue helps them in drinking. They have been accused of gnawing holes in stockings hung before the fire to dry, in order to satisfy their cravings for moisture. Hence, also, it is not an infrequent experience to find them drowned in pans or jugs of liquid.

The house cricket is more or less of a pale brown colour throughout, and, unlike the cockroach, it is fully winged in both sexes, and, therefore, has no need of man's agency to supplement its powers of locomotion. It flies with an undulatory motion, making long rising curves in the air, and dropping at regular intervals. The wings are extremely beautiful objects; in fact, the house cricket contains so many exquisite and delicate structures, that any one who has a few hours to spare, and can devote them, with a good microscope, to the dissection of the insect, will find ample material for interesting study and observation. There are two pairs of wings, the upper pair being more or less horny, and exceedingly different in males and females; and the under pair thin and membranous, and similar in both sexes. When closed, the right upper wing partly overlaps the left, and the under wings project in the form of

long, tapering, rod-like pieces beyond the tips of the fore wings, extending about half as far again as these.

The fore wings are much broader than a casual glance would suggest, seeing that only about two-thirds of their width lies flat along the back, the other third being bent down at right angles to the rest, and lying close along the side. Those of the female are very regularly veined, there being two systems of nervures proceeding in opposite directions, one on each side of the stout ridge at which the wing is bent. But the wings of the male (Fig. 47) are extremely peculiar, and it is in them that

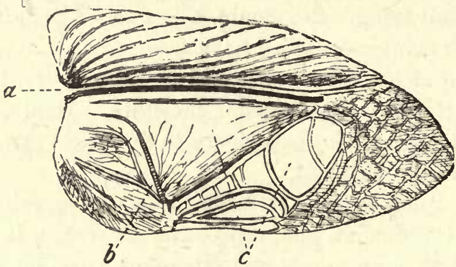


FIG. 47.—Right Fore Wing of Male Cricket. *a*, line of bending; *b*, file; *c*, drum.

the power of chirping resides. There is the same division into two areas as in the female, but the hinder section, *i.e.*, the one that lies on the back, has its veins distributed very irregularly. A stoutish nervure runs straight across this near its base, and then beyond it a large clear triangular area is left almost devoid of nervures. At the apex of this, nearer still to the tip of the wing, is another similar, but smaller and four-sided, patch, with a single, pale, delicate nervure running across it, and the rest of the wing is covered pretty closely with a network of nervures. If, now, these wings be turned over and examined beneath, it will be found that the straight nervure aforesaid is crossed transversely by a

large number of little hard ridges, giving it the appearance of an extremely fine file. These are much too small to be seen with the naked eye, but a moderate magnification, coupled with careful focussing, soon brings them into view. When the chirping is to be produced, the insect bends the fore part of the body slightly downwards, and then slightly raising the fore wings, rubs them rapidly across one another. During this motion, the file of one rubbing against the surface of the other produces a creaking vibration, which is greatly intensified by the clear open plates above-mentioned, which are therefore called "drums." It will now be evident why the females are mute: they have neither "file" nor "drum," and hence are physically incapable of "singing."

It is clear from the above that the chirping is in no true sense of the word either a voice or a song, being quite unconnected with the respiratory organs; it is a purely external and mechanical sound, comparable, as a means of expressing sentiments, rather with the human device of clapping the hands, or flipping the fingers, than with the utterance of sounds with the mouth. Of course it is not to be expected that an insect should make any noise with its mouth other than that produced by eating, since the mouth does not, as is the case with us, communicate with the breathing organs. The entrances to these are in the cricket, as in all other insects, along the sides, and any sound that might be produced in them by the passage in and out of the air would be more strictly comparable with the voice of vertebrate animals. Some insects, as for example the common blue-bottle fly, are able to produce a noise in this way, and may therefore be truly said to possess a voice. But that is by no means the rule, and the sounds insects produce are in general the result of the friction of external parts upon one another.

The hind wings of the cricket are exceedingly delicate, and are each strengthened by about fifty nervures, radiating fanwise from the base. As about half these nervures are weaker than the rest, the weak ones being placed alternately with the strong ones, the whole wing can be folded up lengthwise like a fan, and this accounts for its pointed form as it protrudes from beneath the upper wing. It is this peculiar method of straight, longitudinal folding that has caused the name Orthoptera (*straight*-winged) to be given to the order.

Of course the power of chirping implies the power of hearing. It is only natural to suppose that the male crickets would long ago have abandoned the habit of serenading (if, indeed, they had ever perfected it) if their mates had not been able to recognise their attentions. It is rather curious, however, that this insect, notwithstanding its living in our houses, and the considerable curtailment of its field of quest for partners consequent thereupon, should have preserved almost as strongly as its out-door relative this power of chirping. One cannot help feeling a suspicion that, if this vigorous minstrelsy be merely of an amatory nature, either the gentler sex in the cricket must have become extremely coy, or else there is a vast deal of wasted energy on the part of their swains. However that may be, as the power of recognition of this call seems as though it must be an important matter in cricket economy, we naturally look about for some special apparatus suitable for the detection of sounds, of a much more indubitable character than is generally met with in insects. And the search is soon rewarded. It is only necessary to examine the *tibia*, or shank, of the fore legs, just below its junction with the thigh, to find an organ to which it is difficult to assign any other function. Here, on the flattened outer edge,

is a long, oval, transparent, membranous disc, stretched over a corresponding aperture in the walls of the leg (Fig. 48), and exactly opposite it, on the other side of the leg, there is a similar, but round and much smaller disc. Between these two, in the centre of the hollow shaft of the leg, is a bladder-like expansion of the main breathing tube of the leg. Numerous curiously shaped nerve-endings, having the peculiar form of those of special sense, are distributed at this spot, and the action of the complicated apparatus seems to be such that the membranous disc, vibrating in response to the chirping of some distant individual, communicates its motion to the air within the breathing-tube, which in its turn affects the neighbouring nerves, thus enabling the insect to perceive the sound.

FIG. 48. — Fore Tibia of Cricket, showing auditory organ (*a*).

Projecting from the hinder part of the female's body is a long ovipositor, consisting of a double boring implement, used in depositing the eggs in suitable situations. Large numbers of eggs are laid, and the course of development is similar to that of the cockroach, the eggs yielding small, active, six-legged creatures, something like their parents in form. After a series of moults, these attain by progressive changes, but without any pause in their activity or suspension of their functions, the adult size and form, acquiring wings only at the last moult. The metamorphosis is thus incomplete.

Two long, unjointed, tapering appendages, pointing backwards, project from near the extremity of the abdomen in both sexes. They are furnished abundantly

with very fine hairs, and are probably sense organs, possibly giving notice of impending danger from behind.

Crickets are pugnacious insects amongst their own kind; notwithstanding similarity of habits, however, they are often found inhabiting the same houses as cockroaches. But it seems probable that the steadily advancing armies of the latter insect will, in the course of time, either exterminate them, or compel them to take to an out-door life. This latter they are not averse to doing in the summer time, even now. But from the way in which they hug the kitchen fire, it seems as if artificial warmth is essential for them in the winter.

The family of British Earwigs is a small one, numbering at present six species; no more than two of these, however, are common, and probably most people know only one, which to them therefore ranks as *the* earwig. This is the insect whose scientific name is *Forficula auricularia*, the well-known species which is to be found abundantly everywhere. We will take this common and easily obtained insect as the type of the group, in the hope that our readers will catch one, and follow with us the outline of its form; the deviations of structure which the other species present will then be easily appreciated. The common earwig is so well known that only a few words will be necessary to add accuracy of detail to the rough general idea of its shape and structure that is already in everybody's mind.

Exclusive of the forceps at the end of the body, which vary considerably in size, the common earwig has a length of about half an inch. It has a flat, rounded, reddish head, carrying a pair of fifteen-jointed antennæ, at the base of which, but outside them, are the black, oval, compound eyes, which lie flat and do

not project from the head. No ocelli, or simple eyes, are present.

Behind the head is the thin, flattish, shield-like cover of the first segment of the thorax, which projects at the sides as a kind of flap, and behind laps over the front of the wing-covers. It is dark brownish-black in the centre, with pale yellowish borders. Behind this is a pair of pale yellowish-brown wing-covers, or elytra, which are thin and flexible, and lie flat on the back, but bend down at the sides like those of the house-cricket; when closed they exactly meet, with a straight junction along the middle line. Their hinder edge in reality forms almost a straight line across the body, but at first sight this does not seem to be the case; they appear to have two projecting pieces in the middle of this edge, which remind one of the shape of the two halves of the cloven hoof of a cow, save that they are almost flat. These, however, are not part of the wing-covers at all, as may easily be proved by raising the latter with the point of a needle, when these projections are seen to be in no way attached to them; they belong in fact to the wings, which, except for this part, are entirely concealed under the covers. The wings and their covers when closed, as one usually sees them, are so short that they conceal little more than the hinder part of the thorax, and thus leave almost the whole of the abdomen exposed.

The abdomen is by far the largest part of the insect, being the longest, the widest, and the deepest, so that when the earwig walks, the fore part of the body is elevated a little on the legs, while the abdomen almost trails along upon the ground (Fig. 49). Nine distinct segments can be seen above in the abdomen of the male, but only seven in the female. They are of a mahogany-

brown colour, more or less tinged in places with black. To the hindmost segment are attached the forceps, by which feature alone earwigs can be distinguished from all other insects. They differ considerably in shape in the two sexes (Fig. 50). In the male each forms a curve, so that when closed they constitute the boundaries of an open oval space. On the inner edge, near the base, they are ornamented with small, irregular, tooth-like projections, and beyond these, on each side, there is a solitary but much larger

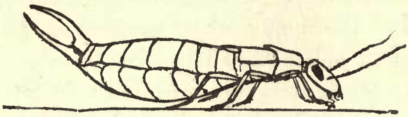


FIG. 49.—Position of Earwig when walking.

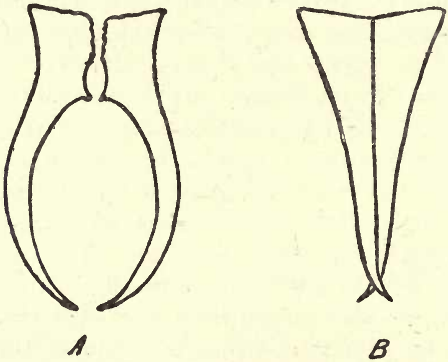


FIG. 50.—Forceps of Earwigs.—A, male; B, female. Shown in the position they take up after death. Magnified six diameters.

one, just where the "legs" of the forceps begin to diverge. The forceps are strong stout organs, of a yellowish-brown colour, with the teeth blackish; they are highly polished, and exhibit in different specimens considerable variety as to length and degree of curvature. Sometimes, through accidents in early life, they become

twisted, or otherwise deformed. Those of the female are simpler and less elegant. They do not curve outwards when closed, but lie side by side as far as the tip, where they cross one another slightly. In both sexes they are habitually carried widely open, and pointing obliquely upwards. The six legs are yellowish and almost transparent, and are composed of the usual parts.

Such is the external aspect of the common earwig, from which we may now pass to consider the structure and manipulation of the wings, which are by far the most beautiful part of the insect, and deserve special attention. It is very seldom that the wings can be seen when the earwig is alive, for they are used chiefly by night, and one can have no conception of their size, or of the beauty that lies concealed under their covers, if one merely watches the running insect; indeed, it is difficult under such circumstances to believe even in their existence. To examine the wings properly, the earwig must be killed. This may be done instantaneously, and without damage, by plunging it into boiling water. Let it then be placed on blotting-paper to dry it, and afterwards laid full length upon some hard surface. Then let the wing-covers be raised and separated a little towards the right and left; a neat little package will thus be found under each, which, strange as it may appear, is really a beautiful transparent wing, folded up into extremely small compass. By dint of care and patience it may be opened fold after fold, till its full extent is exposed, when it will be found to spread over an area some seven or eight times as large as the cover under which it was hid.

The complete unfolding of the wing is a delicate operation, and must be managed methodically. The following method will succeed very well if the directions

are carefully attended to. The wing-cover having been removed by raising it behind, and then gently snipping it off in front with a fine pair of scissors, the folded wing lying beneath may be carefully seized with forceps, lifted up, and snipped off in the same way as the cover, or it may be gently pulled away from its attachment. As it is too small to be conveniently manipulated unless when fixed to some support, a card should be provided on which may be placed, with a small camel's-hair brush, a very little gum tragacanth, made by soaking a small piece of the solid gum in water till it is of the consistency of rather thick paste. The gum will very quickly dry if only small quantities are used, and leave no trace behind. It should not be put on the card till the wing is ready to be transferred to it. The wing packet may now be placed gently on the gum with the *upper* surface *downwards.* In a few minutes the gum will be dry and the wing will thus be fixed (Fig. 51, *A*). By aid of a needle it will now be found that there are two layers of material folded upon one another like the leaves of a book. One of the edges will be observed to be straight, the other curved; the straight one is where the fold occurs. By aid of the needle the flap may be lifted and turned over along this hinge, and pressed down on to another small supply of the gum, which may be put on just in time to receive it. The wing will now of course be twice as broad as before, and will present the appearance shown in Fig. 51, *B*. It will now become evident that the part that has been turned back itself consists of two layers bent upon one another, not in the same direction as before, but with the hinge lying *across* the wing at its upper end. The uppermost flap may easily be bent back across its hinge, when the wing will appear as in Fig. 51, *C*. This last piece should not

be fastened down, but simply pressed back. Now comes the most difficult part of all. The long smoky part which occupies the whole of one side of the wing, as it is now displayed, consists of a thin membrane strengthened by leathery rays, and arranged in a number of longitudinal folds; and the whole is bent

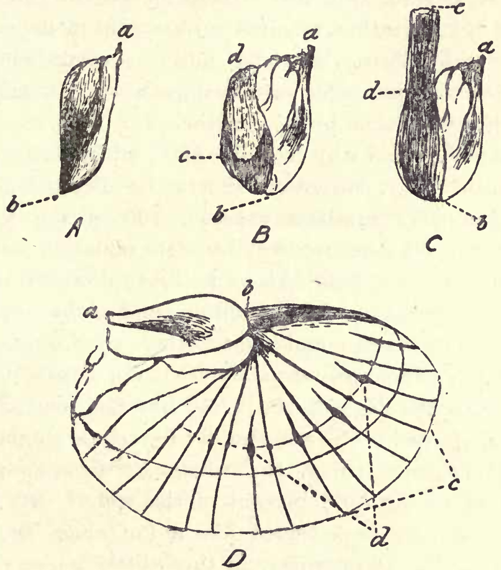


FIG. 51.—Four stages in unfolding Earwig's Left Wing. The small letters represent the same parts in all the figures. Magnified six diameters.

back upon that part of the wing that is attached to the card at the end opposite to the position of the former hinge. It may be lifted at *d*, and as it is raised the membrane gradually opens itself out in all directions. The outer edge may be gently pushed back on to the card, on which another small supply of gum has just been spread; and if care be taken to keep the narrow

dark triangle shown at *b* (Fig. 51, *D*) in the same line as the original outer boundary of the wing, the rest will fall pretty easily into its place, and become neatly spread out on the card. If it does not settle on the gum quite smoothly, the wrinkles may be got rid of by using the needle as a sort of rolling-pin, and rolling it out from the stouter towards the weaker margin of the wing. This last operation requires care, as the membrane is very easily torn. We have now the whole wing expanded with its under surface uppermost. It will keep any length of time in this position.

To understand why the wing always folds in precisely the same way, attention should be directed to the membranous part last exposed. From the joint *b* (Fig. 51, *D*) nervures will be seen radiating like the framework of a fan. About half-way down its length, each dilates into a minute swelling; and as the individual rays diverge more and more, other shorter ones are seen to spring up alternately with them, passing outwards to the edge of the wing, but not reaching the hinge aforesaid. These also have each a similar but much larger swelling, the whole set forming a row parallel to the hind margin of the wing. The membrane, having been folded like a fan along the lines of the radiating nervures, all these little leathery spots are brought up side by side, and the whole collection is then bent across at this spot, thereby reducing the membrane to half its length. A transverse nervure running parallel to the hind margin, but nearer to the line of bending than to it, serves to give stability to the wing when fully expanded. The rays are the divisions of the anal nervure, the area of which in most insects forms only a small part of the wing nearest the body, but in the earwig has so far

expanded and encroached as to constitute almost the whole wing.

The wing readily closes of its own accord at the transverse bends, in virtue of its own elasticity; but obviously this must be overcome in opening by some external force, and it is just here that the forceps at the end of the body come in usefully. The earwig is said to use its forceps to aid the operation, turning them over its back to do so. There is great difficulty in verifying this statement, owing to the nocturnal habits of the creature, and its general disinclination to use its wings. If the wings are opened artificially, the earwig will often go for hours without closing them, and then when it finally does so, probably the experimenter is absent. It is said also to use the forceps in closing the wings, though from the nature of things it would seem that they would be less required then. There are some foreign species whose forceps are as long as the body, and it is difficult to see how these can make such a use of their exaggerated tail appendages. The forceps are of course weapons of offence and defence as well, and are probably quite as effectual by giving a terrifying appearance to the insect as by being actually used for pinching.

The earwig is one of those insects whose metamorphosis is incomplete, like the cockroach and cricket. The eggs are little, oval, yellow things; they may sometimes be found under stones, &c. De Geer has left an account of a mother earwig which he found with a batch of eggs, which implies that these insects, contrary to the general practice, show maternal solicitude. He placed the eggs in a jar, scattering them over the surface of some earth it contained, and then put the mother in. She immediately set to work picking up

the eggs with her jaws, and conveyed them all to the same spot, where she remained jealously guarding her treasure till the young were hatched. And even then the cares of maternity were not over, for the young ones clustered round their mother, running in and out between her legs and under her body, like chickens under the mother hen.

When first hatched the young are quite white, except for the eyes and jaws, which are reddish. They soon darken, however, into a tolerably uniform pale brown. They are very similar in shape to the adult, but have no wings or wing-covers; while their antennæ also have fewer joints, and their forceps are more simple in form. After several moults, each accompanied by an increase in size and a darkening in colour, they appear, like the cockroaches and crickets, with the outline of wings sculptured on the thorax; in this form they are called nymphs or pupæ. The next moult yields the perfect and mature insect, with the full number of joints to the antennæ, wings, wing-covers, and forceps all perfect, and the sexual organs fully developed. At each moult the insect is soft and white immediately after casting the skin, but gradually becomes harder and darker by exposure.

Earwigs are extremely voracious; they are chiefly vegetable feeders, and are especially fond of the corollas of flowers, so that they are a great annoyance to gardeners by nibbling the flowers, and thus spoiling their symmetry. Their method of procedure can be easily watched by putting a few specimens in a glass jar, and supplying them with flowers such as the garden nasturtiums (*tropæolums*). The jaws work in the same way as those of cockroaches, the palpi being in incessant motion all the time.

Earwigs can run up and down the perpendicular sides, even of a glass jar, with perfect ease, an accomplishment very essential to their well-being, as their favourite food so often lies up on the end of a tall stalk. Hence, one can account for their presence in sunflowers and other tall flowers, without assuming that they have flown thither. They habitually rest with legs widely spread out, and this, no doubt, helps to give them a firm foothold. On the other hand, however, as everybody knows, they are extremely ready to relax their hold, and drop at once to the ground if disturbed. They are fond of the darkness, and it would almost seem as though light were painful to their eyes, for they habitually endeavour, when disturbed in the daytime, to poke their heads into some obscure corner.

Earwigs, although they make a good deal of mess in the places they frequent by the abundant accumulation of their excrement, are yet not in themselves of uncleanly habits, but are in person usually scrupulously clean. If watched for a little while, they will be seen cleaning themselves as a cat would do, putting the fore foot up to the mouth, and then rubbing it round the head; the hind foot will also sometimes be bent round underneath, and brought up to the mouth in the same way, and after some tremulous movements with the jaws and palpi, it will be stroked down the back several times, evidently with the intention of removing particles of dust, &c. There is a surprising air of intelligence about them as they perform their ablutions, and a steady, business-like application to the work, which is highly amusing.

A similar appearance of a power of resource and vigour of purpose are often to be seen while they are feeding, especially when an earwig, reaching up to a flower above its head, and almost too high for it, gives

it little tugs with a jerk of the head, like a horse pulling hay out of a rack.

The partiality of earwigs for flowers, and particularly for dahlias, has led to the adoption of various devices in gardens to get rid of them, advantage being taken of their fondness for dark corners. Mouffet, an old writer, speaks of "ox-hoofs, hogs'-hoofs, or old cast things" as being set up in his time on sticks as traps by the country

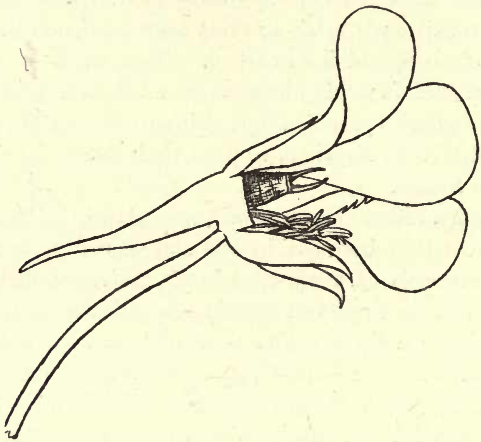


FIG. 52.—Tropæolum flower, with Earwig in spur. Part of the flower has been removed, to disclose the Earwig.

women, to whom earwigs, or erriwiggles, as they call them, are exceedingly hateful, as he says, "because of the clove gilliflowers that they eat and spoyl." Crabs' and lobsters' claws have been used with effect in a similar manner. Into the recesses of these the earwigs delight to penetrate in the daytime, just as they have learned to do into the spurs of the tropæolum flowers (Fig. 52), since these were introduced into British gardens. But the creatures are so ubiquitous, so abundant, at least in

this country, and so determined to skulk out of sight in the daytime, squeezing themselves into most out-of-the-way places, under stones, tiles, bark, leaves, or garden rubbish of any kind, wherever there are but a few cubic millimetres of breathing space, that it is next to impossible to devise means which shall be very effectual in reducing their numbers.

Not only do they damage flowers, but, like wasps, they are destructive to ripe fruit as well. De Geer fed some of those he kept with chopped apples, which they eagerly devoured. Windfalls from the fruit trees in orchards are soon found out and excavated by earwigs, which in the daytime curl themselves up in the hollows they have made in the fruit, sticking close to their booty, ready to fall to again as soon as the promptings of hunger and the return of darkness combine to render a banquet desirable and safe. Though, as a rule, vegetarian in diet, yet they have no objection to eating animal food if opportunity serves, and may even, when hard pressed, resort to cannibalism; but experiments seem to indicate that they will be prepared to suffer great extremities before falling back on such a practice. They may be kept for a long time in numbers together, without showing any disposition to attack one another, even if the supply of food be scanty. They are not often found indoors, but if accidentally introduced, may sometimes do irretrievable damage. The entomologist especially has to be on his guard against them. If they do manage to gain access to his setting boards, they have no hesitation in trying their jaws upon the insects that may be stretched on them. The antennæ of dried insects, particularly of certain special kinds, seem to be peculiarly delicate morsels, and the earwig makes for them first. One collector records that a single

earwig passed along his boards, and in two days removed the antennæ from thirty-six moths all belonging to one species, while examples of other species were left untouched. The entomologist who hunts for moths at night by smearing the syrupy liquid, technically called "sugar," on the trunks of trees, as a bait, often finds, on revisiting his trap, that crowds of earwigs have found out the store, and are revelling in the tempting sweets.

Notwithstanding their retiring habits, earwigs do not escape the attacks of parasites. Westwood states that there is a kind of ichneumon-fly which attacks the common earwig, depositing eggs in its body, the contents of which are devoured by the larvæ hatched from them; and I have myself found a large fleshy maggot, apparently that of a flesh-eating Dipterous fly, inside the body of a full-grown earwig. Internal insect parasites, such as these, whether Hymenopterous, like the ichneumon-fly, or Dipterous, like the maggot above referred to, when attacking insects which pass through a complete metamorphosis, usually become mature while their host is in the chrysalis condition, and thus the latter does not itself reach maturity, but perishes while still a chrysalis through the development and exit of the parasite. Here the very fact of the host's being in a quiescent condition, and taking no food, is the means of sounding its own death-knell, the parasite absorbing its vital tissues, while it has no power of repair. The parasite is complete master of the situation, and, in consequence, it is the rarest thing imaginable for the host to struggle on to maturity. But with such an insect as the earwig, the case is different. Here we have an insect which has no quiescent pupa stage, but continues to take food throughout life, thereby to some extent perpetually neutralising the effect of the parasite's

attacks; and it is hardly surprising, therefore, that in such a case the maturation of the parasite should be delayed till much later in the life of the host, and that the latter should thus be able to reach maturity in safety. As a factor in the perpetuation of its race, however, it would probably be just as devoid of influence as if it had died in pupahood, as the parasite would probably subsist at the expense of its reproductive organs, and thus render it barren. The exit of the parasite, under such circumstances, would be an interesting event to witness, and one would be glad to know the precise point at which it escapes, as well as the means by which it bursts through, for the skin of the perfect earwig is much harder and tougher than it is during the larval and pupal stages, and the parasite is therefore much more effectually imprisoned. Besides these insect parasites, a *Filaria*, or threadworm, has been discovered infesting the common earwig, as well as a *Gregarina*, a creature of much simpler organisation even than the threadworm.

The systematic position of earwigs has been a matter of considerable controversy. They constitute a very compact family—the *Forficulidæ*—and were placed by Linné in the order Coleoptera, or Beetles. In some respects they certainly do exhibit a tolerably close resemblance to one particular group of this order, viz., the rove-beetles, a set of carrion and dung-feeders which are technically called *Brachelytra*. These are beetles of narrow elongate body, with very short wing-covers, so that the greater part of the abdomen is exposed, instead of being, as is generally the case, concealed beneath the over-arching elytra, or wing-covers. It was this small size of the flying apparatus which suggested the name of the group, *Brachelytra* being Greek for "short

elytra." Some of the larger species of this group (Fig. 53) are about the size of earwigs, and in consequence of their elongate form and short elytra, are very generally mistaken for them, the resemblance being sometimes heightened by the presence of short, pointed, projecting organs at the end of the body in the position of the true earwig's forceps. But the resemblance is after all only a superficial one. No true projecting *forceps* are ever developed in the rove-beetles; their wings are differently veined and differently folded from those of earwigs; and lastly, and most important of all, the life-histories of the two groups are utterly unlike, for the rove-beetles pass into a quiescent chrysalis stage before becoming perfect insects, which is never the case with earwigs. By later systematists, the earwigs were removed from the Coleoptera and put into the Orthoptera, amongst the cockroaches, crickets, grasshoppers, and locusts, forming, however, a distinct section of the order. In the nature of their mouth-organs and the style of their metamorphosis they do indeed resemble these insects, yet they are so peculiar in the matter of the wings that their location with the Orthoptera did not satisfy all naturalists; consequently Kirby, in 1823, removed them and made them into a separate order by themselves, under the name Dermaptera, an unfortunate piece of nomenclature, since this term had previously been adopted as the name of the whole order which is now called Orthoptera. Westwood therefore proposed to replace the name Dermaptera

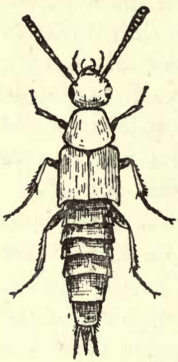


FIG. 53.—*Philonthus æneus*, a Rove-Beetle, sometimes mistaken for an Earwig. Magnified three diameters.

by Euplexoptera (well-folded wings), in allusion to the complicated system of wing-folding which distinguishes earwigs; but the pendulum has again swung round in the opposite direction, and they are now again grouped, at least by professed entomologists, in the order Orthoptera.

We may conclude with a brief reference to the peculiarities of the popular names of these well-known pests. It is remarkable that in almost all the languages of Europe they are known by names which have some connection with the word "ear." It is always the ear "worm," "borer," "piercer," "twister," or something of that sort—names which obviously reflect the vulgar and wide-spread superstition that the earwig creeps into the human ear, and causes death by effecting thence an entrance into the brain. It is curious that so manifestly absurd an idea should ever have gained such wide credence—so wide indeed as to have been incorporated into the traditional lore of all the most civilised nations of the world—and still more so, that it should even yet show strong signs of vitality. Such a notion, of course, explains the popular prejudice against the earwig, which, indeed, is not an insect that has ever succeeded in inspiring either admiration or respect; on the other hand, superstitious fear, hatred, or contempt have generally been the feelings with which it has been regarded, and even its name was once used as a scornful epithet, a synonym for an "inquisitive informer"—no doubt in allusion to its habit of poking its head into corners.

CHAPTER XI.

HOUSE FLIES AND BLUEBOTTLES.

THE swarms of flies which in the summer months invade our houses, and disturb our peace, both of mind and body, are of several different kinds. Popularly, the smaller species are usually called indiscriminately "house flies," or, indeed, simply "flies," and the larger ones "bluebottles," whereby names that, strictly speaking, belong to certain species only, are vaguely used for a variety of forms more or less distinct. In the heading to this chapter we have deferred to popular usage, and intend to include under these two well-known names all members of the family *Muscidæ* that render themselves obnoxious to us in our indoor life, either by their persecution of our persons or their raids on our belongings. At the outset, therefore, it may be as well to make some attempt at discriminating species, that we may know exactly what insects we are talking about.

The *Muscidæ* are an enormously large and very puzzling family of the two-winged flies, which constitute the order Diptera. Only a very few species of this great family can in strictness be included as household pests, and first on the list may be placed the house fly proper (*Musca domestica*). This is a medium-sized and inconspicuous insect, which, at first glance, seems to have no special adornment of any kind, but to be simply of a more or less uniform greyish black, with transparent

wings slightly tinged with grey. But this first impression will be corrected by a closer scrutiny, which will discover many quiet beauties of one kind and another. Two of the chief items which determine the personal appearance of a fly belonging to this group are stiff projecting hairs (or rather bristles), and what at first looks rather like a kind of rime; but on microscopic examination turns out to be crowds of exceedingly minute hair-like or scale-like bodies lying close to the skin. The latter are mainly instrumental in producing whatever colour forms patterns or markings upon the otherwise frequently dull bodies of flies, while the varying size and number of the former exercise an important influence upon the general aspect of the insect, and make all the difference between a sharply defined and an indistinct outline of the body.

The skin of the house fly, on the upper surface, is in itself chiefly black; but the rimy covering (called collectively "tomentum"), which is scattered pretty thickly over it in most parts, gives it a greyish spotted appearance on the abdomen, causes also the resemblance of four dark lines of the thorax, where bare spaces are left, and beautifully adorns the face with a bright silvery covering. The large compound eyes are of a vinous red, and present a pretty contrast to the soberer colours of the rest of the insect. Underneath, the fly is quite pale, *i.e.*, the ground colour of the skin itself is pale, as well as the tomentum. Its bristles are not sufficiently large or numerous to become a noteworthy feature in its aspect. It has no power of stinging or piercing, and, therefore, is not a bloodsucker, and simply worries us by the tickling sensation it produces when trying to sip the perspiration from our hands or face, or when simply running over the exposed parts of our

bodies. It further annoys us by the dark spots of fluid excrement (fly-spots) with which it disfigures any object over which it runs. It is notably the fly of the sugar-basin, for sweets seem very attractive to it; but it is not addicted to the habit of laying eggs on cold

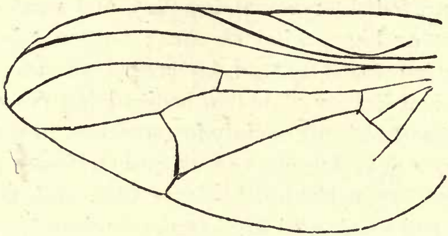


FIG. 54.—Wing of *Homalomyia canicularis.*

meat. It is most abundant in the end of summer and towards autumn.

Very much like this insect, but rather smaller, is a fly which was formerly known as *Musca domestica minor*, the "smaller house fly." It is now called *Homalomyia*

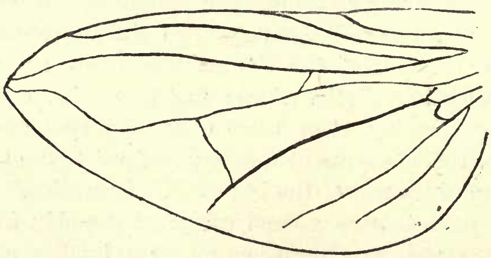


FIG. 55.—Wing of *Musca domestica.*

canicularis, and may be distinguished from *M. domestica* by its paler and much more pointed body, which is of a conical shape, and especially by the arrangement of its wing-nervures. To appreciate this distinction, the accompanying diagrams (Figs. 54 and 55), representing

the wings of the present insect and *Musca domestica*, may be compared. The chief difference will be seen towards the tip of the wing. If the third nervure on the disc of the wing in this part be compared in the two, it will be found to make an obtusely angular bend forward to the tip in *Musca*, but only to run forward to the margin without any angular bend in *Homalomyia*. This feature, taken in conjunction with the others here mentioned, will greatly aid the identification of this little fly. The male, which is by far the commoner sex, has at the base of the abdomen large pale patches, which are semi-transparent; hence, when the fly is sporting about on the window-panes, as it delights to do, the light shines completely through that part of the body, the pale patches looking like windows provided for the inspection of its internal anatomy. This little fly, especially the male, delights to hover and sport about in our rooms, and is exceedingly common. It has brilliant red eyes in exquisite silvery settings, like its larger relative, save that the colours are more intense.

Of a more robust type than this, with broader and shorter body than even the house fly proper, is an insect which may be at once distinguished by the curious shape of its proboscis, which projects straight in front of its head like a sharp-pointed needle. It is a far more troublesome creature than the other two, as a glance at its vicious-looking proboscis would immediately suggest. It is one of the so-called biting or stinging flies, and has earned an evil reputation by its persistent habit of piercing the skin for the purpose of sucking blood. It will, of course, not be confounded with the gnat or mosquito, which belongs to a totally different family, and one to which we are not now alluding. This stinging fly is named, very descriptively, *Stomoxys*

calcitrans, the "sharp-mouthed stinger." If seen by itself, it would probably be mistaken for a house fly, unless the extraordinary nature of the proboscis were noticed; but when the two insects are placed side by side, many other differences become apparent, at least to the trained eye. *Stomoxys* is not only smaller than *M. domestica*, but it carries its wings wider apart when not flying, and is more thickly covered with a greyish tomentum; its eyes, moreover, are not so red. But the strongest point of difference lies in the proboscis, and in the disagreeable habits of which that is the surest indication. These three flies constitute the majority of what in houses are commonly regarded as house flies, or are simply called flies.

But, besides these, there is the far larger bluebottle, blow-fly, or meat-fly; this is usually one or other of two closely allied species, *Calliphora vomitoria* and *C. erythrocephala*. A bluebottle is easily recognisable by its much larger size, its proportionally broader body, of a shiny blue or violet colour, and the loud buzzing with which it heralds its approach. Like its companions, it is red-eyed, but its face is not silvery, only a narrow margin of silver being visible behind each eye, while all the lower parts of the face are more or less of a pale reddish-yellow; it is also more hairy than the other species. When in good condition, it may be seen to possess a tomentum like the others; and this, in certain lights, imparts a curious appearance to the steely blue of the skin, reminding one of the lustre of shot silk. These flies are, in the house, the chief assailants of cold meat, of which they not merely suck the juices, but on which they deposit great numbers of eggs, known as "fly-blows," whence will issue maggots whose one business will be to demolish the solid parts. Thus each

of the above species, all of which are exceedingly common household pests, is distinguished not merely by a characteristic form, but also by habits peculiar to itself.

Besides these, several other species also sometimes invade our houses, and it must be remembered that in all cases it is an *invasion:* none of them are home-bred, but all have spent their early life and passed through their metamorphoses out of doors. It would indeed be a disgrace to our civilisation if the interiors of our houses afforded any suitable breeding-ground for such creatures: they are all nurtured amidst putrid and refuse matters, and the mere sight of their hideous, worm-like larvæ, commonly known as maggots or gentles, is enough to fill one with disgust and loathing. Most valuable, however, are their labours in this stage of their life: they are the great scavengers of the earth, and contribute in no slight degree to the purity of its atmosphere. Of the other *Muscidæ*, that, in their adult condition, more or less frequently occur indoors, we need not stay to speak now, but will reserve a few remarks about them till the end of the next chapter. The above five species will be the only ones we are concerned with at present, as they will probably be the chief representatives of the family met with in towns. In the country, of course, many others will be added to the list, since an open window in such situations proves to not a few of the other restless two-winged insect inhabitants of fields, hedges, and ditches, a temptation too strong to be resisted. But even in such cases, the above species will greatly preponderate. Some years ago, I was staying, in the month of August, at a country house which was suffering from an exceptionally severe plague of flies: they swarmed in every window, of which there were not a few, and made an intolerable buzzing. As they died their carcases

accumulated on the window-sills. On examining the heaps of bodies, a considerable variety of species was discovered, and several were noticed whose presence was quite unexpected; still, out of many scores of specimens examined, by far the largest proportion consisted of the one species, *Stomoxys calcitrans.*

As all five of the flies mentioned above belong to a single family, the *Muscidæ,* they exemplify the same structural type, and, except in a few matters of detail, one may be taken as representing all. To illustrate the main points in a fly's structure, therefore, we will select the bluebottle or blow-fly (*Calliphora*), as it is the largest of the indoor species, and can always be easily obtained. We will suppose that we have before us one of these flies, which has been killed without crushing or otherwise damaging the body. This can be done by means of the fumes of chloroform, cyanide of potassium, or crushed laurel leaves, any of which will, in a few moments, render such an insect insensible, while a longer exposure to the poisonous vapours will kill it entirely, and leave it in a good condition for examination.

The distinguishing feature of the order is at once noticed in the single pair of membranous wings placed horizontally over the back when at rest, and extended at right angles to the body when in use. As the Diptera are the only order of insects in which a single pair of wings is normally present, there is very little difficulty in distinguishing them, and there are very few other insects that can possibly be mistaken for them. Each wing consists of a thin double membrane, strengthened by six longitudinal hollow ribs or "nervures," of which the larger contain breathing-tubes (tracheæ) and nerves. The nervures are not scattered at random, but always, as in other orders, follow a definite course, which varies

somewhat in different genera or even species, but is constant in the same, and the general plan is sufficiently definite to permit of the individual nervures being identified and named, so as to be used as aids in classification. A comparison of the accompanying drawing of a bluebottle's wing (Fig. 56) with those of the larger and smaller house flies given on p. 174 will further show what sort of differences may be expected in this respect. The present plan is very much like that of the house fly proper, and the chief difference is in the præbrachial nervure (the third on the disc of the wing towards the

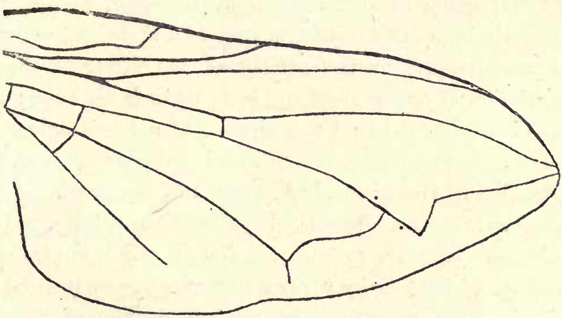


FIG. 56.—Wing of Bluebottle (*Calliphora*).

tip). In the present species it will be found first to bend at right angles towards the nervure above it, and then to slope towards the margin, while the little cross nervure (discal transverse) which joins it to the next below, meets it very much nearer its upward bend than in *Musca domestica.* The front edge of the wing is bounded by the strongest of all the nervures, the costal, which is furnished, towards the base, with a row of short bristles. To the naked eye the wing appears to consist only of membrane, and to have no clothing of any kind; but microscopic examination shows a multitude of

extremely minute hairs distributed all over its surface, but very evenly and regularly disposed. There are also larger hairs on the nervures, which may perhaps be sensory in function.

The wings can be vibrated with marvellous rapidity, sufficiently so to produce a recognisable musical note. Attempts have been made to determine the number of vibrations per second by observing the pitch of the note. The usual pitch of a fly's hum is somewhere about the notes E or F, and the corresponding number of vibrations would be something between 320 and 350. The characteristic *buzzing* of our bluebottle, however, is not due to the vibration of the wings, nor, like the shrill song of the grasshopper, or the squeak of the water-beetle, to the friction of one part of the body against another; for Landois discovered that the thorax of a bluebottle continued to buzz with scarcely diminished vigour after the separation of the wings, legs, head, and abdomen. There is also a large and beautiful yellow-banded fly, called *Sericomyia borealis*, not uncommon in our mountainous districts, which has by several observers been noticed to "sing" whilst at *rest*. The Rev. J. Hellins, of Exeter, thus writes of it in December 1881: "One day during the past autumn I went with a small party for a walk on Dartmoor, near Okehampton. After some miles of rough tramp up and down several tors, as the afternoon was drawing on, we found ourselves on a heap of stones on the top of Cawsand, and were glad to rest there awhile. Before long, a piping sound was audible, and one of the party said the wind was whistling; but to this explanation I demurred, having some recollection of having heard the noise before; so, looking round, I soon saw several large flies resting on the stones, and was presently able to convince my friend that the sound

came from them." In the case of the bluebottle, at least, and also probably in that of the other fly as well, the sound-producing organ is connected with the thoracic spiracles or breathing apertures, and the harsh and stridulating character of the sound suggests what appears to be really the case, that it is caused by the vibrations of hard solid bodies. A hemispherical cavity intervenes between the spiracle and the main tracheal trunk, and in this are situated some hard chitinous processes, by the vibrations of which it is believed that the sound is produced.

Closely connected with the remarkable power of the wings is the peculiar development of the thorax, which is so characteristic of the Diptera. Roughly we speak, with reference to insects in general, of the second apparent division of the body as the thorax; but it by no means follows that the part occupying that position and most distinctly visible when viewed from above is homologically the same in all cases. The complete thorax is composed of three segments, called respectively pro-, meso-, and meta-thorax; but in the more highly specialised groups of insects, these three are not equally developed, and sometimes it is one, sometimes another of the three parts, the development of which on the upper surface preponderates over that of the rest. Thus in the Coleoptera (beetles) and Hemiptera (bugs), what is frequently called the thorax on the dorsal view, is in reality only the pro-thorax; in the Hymenoptera (bees, &c.) it consists mainly of both meso- and meta-thorax, and in the Diptera almost entirely of the meso-thorax. This is the division to which the fore-wings of all insects are attached; and as in the Diptera this is the only pair of wings that is developed as such, the peculiar conformation of the thorax of a fly finds herein an explanation. The chief thoracic

muscles are not attached to the wings themselves, but run from one part of the walls of the thorax across to the opposite wall, so that the greater part of the vibration of the wings is produced by alternating changes in the shape of the thorax.

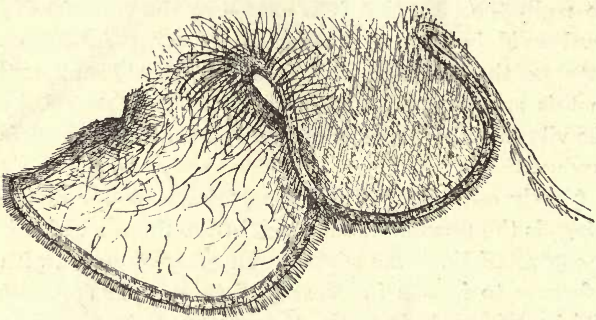


FIG. 57.—Right Winglet of Bluebottle (*Calliphora*).

At the base of each wing is a double membranous scale, the *alula*, or "winglet" (Fig. 57); each of its divisions has a rounded and thickened outer edge, and the membrane is extremely closely covered with minute hairs similar to those on the wings, the larger part having in addition some long flexible hairs arranged pretty regularly but not closely, in rows. The free edge of each is also very closely fringed with delicate hairs. When the wings are stretched out for flight, these scales form a continuation of their area as far as the centre of the hind margin of the thorax; hence the inner scale has, as shown in the accompanying figure, a sloping edge where it fits under the side of the triangular termination of the thorax. But when the wings are closed, the outer scale is folded over the inner side along their line of junction, as well as under the wing itself, so that they lie one upon another like the leaves of a book. It is impossible to say what

is the significance of these *alulæ*. Though connected with the wings, they can hardly have much influence upon flight, and the peculiar arrangement of the double fold, together with the remarkable profusion of hairs, seems to suggest some other function. They reach their highest development in the family *Muscidæ*.

A little distance beneath the larger fold of each *alula*, and entirely overarched and concealed by it, is an organ (Fig. 58) which is highly characteristic of flies. It consists of a slender stalk carrying a globular expansion at its outer end, and near the point of attachment of the stalk to the thorax are three minute sets of rows of papillæ with hairs. These stalked globes are called *halteres*, balancers, or poisers. They are most conspicuous in such flies as the daddy long-legs, or crane flies, and in the bluebottle are reduced to extremely small dimensions, so that they are not likely to be noticed at all unless carefully looked for. It is curious that the development of the *alulæ* is always in inverse proportion to that of the *halteres*. Though so minute, their structure is sufficiently elaborate to suggest that they must be of considerable importance in the economy of the insect, and many different functions have been more or less conjecturally assigned to them. Their names, as above, indicate a notion once current that they helped the insect to maintain its equilibrium during flight; they have, again, been considered to be organs of hearing, or to be

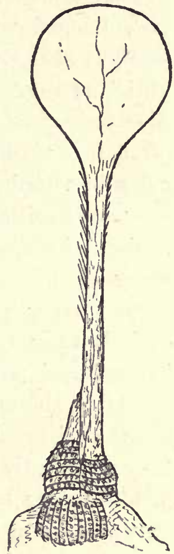


FIG. 58.—Balancer of Bluebottle (*Calliphora*). Showing Basal Papillæ and Nerve.

in some way connected with respiration. Situated as they are on the meta-thorax, they appear to be the representatives of hind wings.

The legs of the bluebottle consist of the usual parts, and there is nothing of special interest or importance till we come to the feet (Plate I.). All the tarsi consist of five joints each, and are terminated by a pair of curved claws, under each of which is placed a fleshy pad, fringed with hairs, and between the pads is a straight sharp-pointed spine. In these pads, or "pulvilli" as they are called, lies the secret of the power flies possess of running over surfaces in any position, often in defiance of gravity. A fly finds no more difficulty in running up or down a vertical window-pane, or across a ceiling, than in walking on the upper side of a horizontal surface. This is not the case with all insects, many of which would struggle in vain to mount a perpendicular glass surface; hence it cannot depend entirely upon the claws, for these are developed in all insects, and would therefore give all equal facilities. No doubt the claws are of some help when the surface is at all irregular, as, for example, on a ceiling; but they can hardly be of much use in travelling over glass. We therefore look to the pulvilli for the explanation. It was at one time supposed that their efficiency depended upon atmospheric pressure, and that they acted like suckers, the edges being closely applied to the surface, and the centre part pulled up so as to create a vacuum beneath. This explanation, however, seems to be negatived partly by the absence of any mechanism to produce such a vacuum, and partly by the presence of great numbers of minute hairs on the under surface, which could hardly do otherwise than interfere with such a close application of the edges of the pad to the

surface as is required by the hypothesis. The mechanism which brings about these curious results must rather be sought for in the hairs themselves. The pads are, in fact, hollow, and contain, protruding into their cavity, the nipple-shaped ends of a sac which occupies more or less of the interior of the last four tarsal joints. This sac secretes a perfectly clear viscid liquid, which exudes into the pad, and from that into the hairs which project from it. These hairs, which are said to number about 1200 on each pad, are hollow, terminate in tubular orifices, and are kept full of the secretion. Hence the entire surface of each pad is crowded with a number of viscid points; and as there are in all twelve pads, two to each foot, these, when applied to the surface over which the fly is walking, produce an adhesion sufficiently strong to support the slight weight of the insect. The viscid liquid soon hardens on exposure to the air, but no doubt remains liquid while covered by the pad. Thus the insect is, as it were, at every step, temporarily glued to the surface over which it is travelling, and leaves on a clean surface little rows of dots as its footprints. This does not necessarily involve any violent strain in wrenching the foot off again, since the tarsus is raised obliquely, and each row of hairs is therefore successively detached, somewhat in the same way as a piece of court plaster may be easily removed from the hand by taking it up at one end and raising it obliquely, though it might resist a considerably greater strain if merely pulled at one end without raising, all the points of contact then combining to resist the strain.

There yet remains the head of our bluebottle to be examined. It is a broad almost triangular plate, united to the thorax by a junction so slender and delicate that

the whole head is readily rotated round it through an angle of more than ninety degrees either way; hence often happens in the dead and dried specimen a catastrophe most unwelcome to the possessor of a collection; a jar or jerk, or an accidental touch, instantly severs the head from the body and ruins the specimen. This unenviable notoriety flies share with dragon flies. Under the microscope the head is a really handsome object, especially when viewed with reflected light. The multitude of detail, the quaintness of form of many of the parts, and the harmony of coloration throughout, combine to make it an object to which only a long and attentive examination can do justice.

The sides are almost entirely occupied with the enormous and strongly convex masses of the compound eyes (Fig. 59), of a colour varying from bright red to dark brown. This appearance is caused by the pigment beneath showing through the transparent cornea; behind, they are delicately bordered with silvery tomentum. The facets, very numerous, and for the most part hexagonal in outline (Plate I.), cannot be made out at all without the help of a lens, and then only when a good light is playing on them. Their form is best seen by stripping off the transparent cornea, and examining it with transmitted light. It depends on the sex what proportion the area of these eyes bears to the whole surface of the head. In the males the eyes spread farther towards the centre of the face than in their partners, and in some flies, as, *e.g.*, the smaller house fly (*H. canicularis*), the eyes of the males come completely into contact on the forehead, those of the females remaining some distance apart. Flies whose eyes meet in this way are said to be "holoptic" (whole-eyed).

On the summit of the head, or crown as it is called,

there is a small raised area, in which are situated three shining hemispherical knobs of a ruby-red colour. These are the simple eyes, or "ocelli" (Fig. 60). They are placed so as to form a triangle with the apex pointing forwards, an arrangement in which, as already pointed out, flies resemble bees, wasps, and other

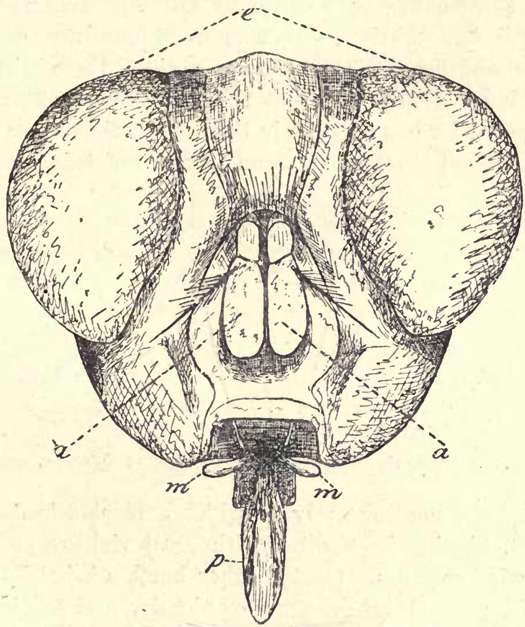


FIG. 59.—Head of Bluebottle, the hairs having been removed. *e*, eyes; *a*, antennæ; *p*, proboscis partly unfolded; *m*, maxillary palpi.

Hymenoptera. In the centre of the triangle two stout bristles stand more or less erect, like guardians of the ocelli, as perhaps they are, and others, larger still, stand facing one another at the sides, forming the commencement of two rows, which run down the face. Quite a forest of much smaller bristles rise amongst the ocelli,

forming a sort of brushwood undergrowth to the large ones. As these bristles readily break off, they can only be seen in their perfection in comparatively fresh specimens. It is a curious fact that the large bristles are very constant in their arrangement and position, so that names have been assigned to them, and the plan of their distribution has been called by Osten-Sacken "chætotaxy," *i.e.*, bristle arrangement. There are several groups of flies that are entirely devoid of these bristles; and it has been pointed out that those flies that possess them are far less cautious in their flight than those that are without them; and, as an instance of this, we may

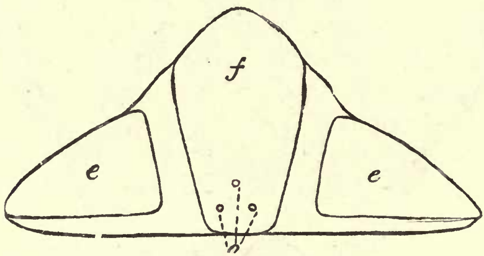


FIG. 60.—Profile view of head from above. *f*, face; *e*, eyes; *o*, ocelli.

notice the headlong way in which a bluebottle dashes about, flinging itself often with great violence against the window-panes. On the other hand, a bristleless fly would proceed much more cautiously, and would be prone, which a bluebottle is not, to poising itself in the air on the wing. The best example of this may be seen in the beautiful yellow-banded "hoverer flies," or "wasp flies," as they are sometimes called (*Syrphidæ*), which delight to hover round flowers, maintaining themselves in one position by an extremely rapid vibration of the wings, which gives them the appearance of a distinct dark body, surrounded by a sort of misty halo. Now

the flies that have no bristles rarely use their legs for locomotion; they fly rather than run from place to place; whereas the bristly flies use their legs quite as readily as their wings, and hence run more risk of collisions with other objects than do those whose time is spent chiefly on the wing. In consideration of these distinctions, it has been suggested that the bristles are protective in function, and serve as a sort of buffer in case of collisions. Whatever may be thought of this idea, the constancy of both number and arrangement of these bristles in the species in which they occur seems to indicate that they have some important function to fulfil in the economy of the insect.

Below the platform on which the ocelli are situated, there is, in the female, a broad flat area between the compound eyes, which slopes outwards and forms the ascent to the summit of a conical protuberance, which is best seen when a profile view of the head is obtained from above. It is a kind of avenue, bordered on each side by the rows of bristles above referred to. In the male, and more particularly in those species which are holoptic, this avenue is, of course, largely encroached upon by the eyes, and in the latter case becomes merely an elongated triangle. Below this bordered avenue is a considerable depression, the outline of which is egg-shaped; at the upper and narrower end of this are attached the antennæ, which are of a most peculiar form, quite characteristic of the particular section of the fly order to which the bluebottle belongs.

Each antenna consists of three joints, the two basal ones being short and conical, and the outer one long and parallel-sided, and far larger than the others. Near the end of this nearest the head, springs, at an angle, a sort of feathery plume, consisting of two or three

minute joints, followed by a long tapering bristle, from the sides of which project other similar but smaller hairs. This style of antenna, viz., three joints and a terminal bristle, is the usual type amongst a large section of the order Diptera, which, from the shortness of the organ, are called Brachycera (short-horns), the other division, Nemocera (thread-horns), containing only the gnats, mosquitoes, daddy long-legs, &c., in which the antennæ are of the ordinary tapering, hair-like type. In the bluebottle, the terminal joint of the antennæ is exceptionally large, and is probably connected with the wonderful acuteness of the sense of smell which distinguishes the species. Its whole surface is crowded with tiny hairs, and between these the skin is covered with enormous numbers of extremely minute clear dots, some 17,000 or 18,000 having been estimated by Lowne as the number for each antenna. Scattered amongst these are also a few larger ones of a similar character: they are minute pits, the larger of which at least are in communication with nerve-threads.

That antennæ may be organs of smell seems to be indicated by experiments on the part of several observers. Take, for example, one of Sir John Lubbock's. Speaking of an ant which had been tethered to a board, he says, "I approached the feather of a pen very quietly, so as almost to touch first one and then the other of the antennæ, which, however, did not move. I then dipped the pen in essence of musk, and did the same; the antenna was slowly retracted and drawn quite back. I then repeated the same with the other antenna. If I touched the antenna, the ant started away, apparently smarting. I repeated the same with essence of lemon and with a second ant. The result was the same." Now, when we remember the annoying cleverness

bluebottles manifest in finding out where the meat-safe is kept, and that, too, not merely should the meat be actually becoming tainted, and therefore distinctly odoriferous, but even before with our blunter senses we can detect any odour at all, except on close approximation, it seems clear that the olfactory sense must be highly developed. When again, bearing this in mind, we notice the exceptional development and peculiar structure of the third joint of the antennæ, and couple with this such experiments as that referred to above, it seems highly probable that the antennæ, of whatever other use they may be, at least serve the bluebottle in lieu of a nose. The very position of the antennæ, too, in front of the face, gives the fly an advantage in following the scent, and thus we may think of this hyæna of the insect world pursuing its hunt for carrion, and, bloodhound-like, following the trail by trusting to the guidance of its antennal nose, searching for that which is not merely to serve as temporary food for itself, but also, and chiefly, as permanent subsistence for its progeny.

All the lower part of the face is red, and the two bulging cheeks are thickly whiskered over with black bristles. Below the hollow in which the antennæ are lodged is a wide groove, which receives the mouth-organs when they are not in use. These are all in one piece, the so-called "tongue" or "proboscis," which is hinged to the head at the hinder part of the groove. As it is gradually opened out, the two bright reddish club-shaped maxillary palpi are seen guarding the aperture. Plate II. shows a photograph of about two-thirds of the "proboscis," taken from a microscopic slide. This is all that is generally mounted, the basal part being cut off because it does not so readily flatten

as the rest. As this preparation is much flattened out, and only its chitinous parts are present, all the rest having been dissolved away, it should be compared with the organ in its natural condition, in order to understand the action of the different parts. The proboscis itself consists of three regions (Fig. 61), the basal part by which it is hinged to the head, a central part bounded above and below by hard chitinous portions, and thirdly the two flexible lobes which form the extremity of the whole organ, and are called labellæ. These will, of course, be closed up like the leaves of a book, and not opened out as seen in the photograph, and their true shape and exquisite structure cannot be made out in this position. Each lobe contains about thirty channels, some of which spring from an inner marginal tube on each side, and all are open to the air by a narrow groove along the under surface. Their form is maintained, and their walls kept in position by numbers of incomplete chitinous rings, in the form of a curve, pointed at one end and forked at the other (Fig. 62); these are placed alternately in opposite positions, so that, on each side, the forked ends of one series alternate with the undivided ends of the other. This arrangement gives the channels somewhat

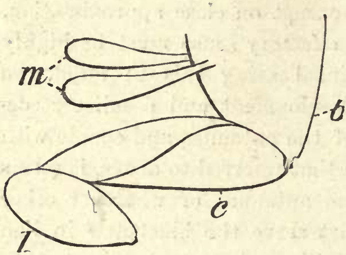


FIG. 61.—Side view of Proboscis, partly opened. *b*, basal division; *c*, central division; *l*, labellæ; *m*, maxillary palpi.

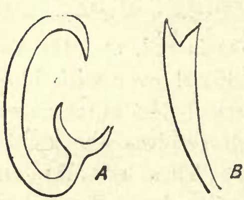
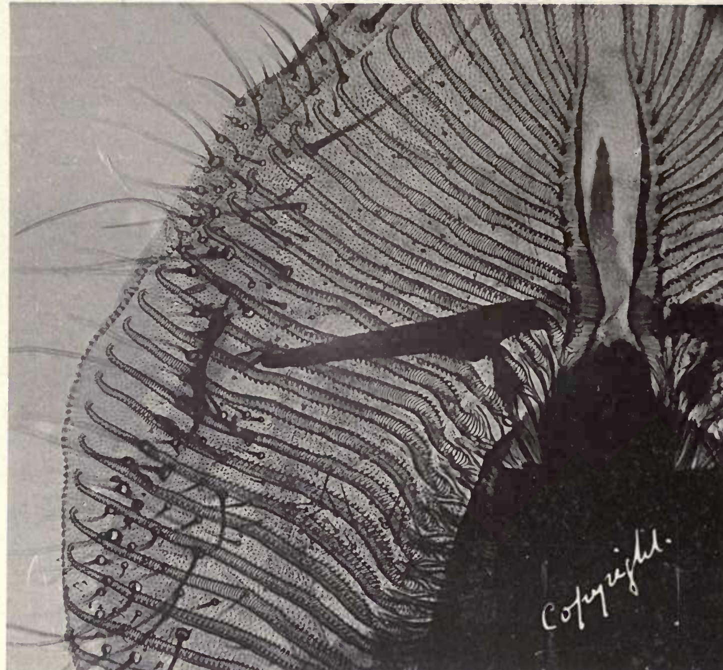


FIG. 62.—A, Ring of pseudo-trachea; B, Tooth of Bluebottle.

FLY S "PROBOSCIS," showing hard parts only, and with labellæ opened out to display their structure. Magnified about 40 diameters.

PORTION OF ONE LABELLA OF SAME, showing curved rods in sucking grooves, and forked teeth at their base. Magnified about 150 diameters.



the appearance of breathing tubes or tracheæ; they differ, however, in being open on their ventral faces, and in having the strengthening rings, not merely incomplete and unconnected with one another, but also much stouter and farther apart than would be the case with tracheal tubes. On account of their superficial resemblance to the latter, however, they are called *pseudo-tracheæ*. The photographs in Plate II. show their microscopical appearance. They are, of course, not breathing organs, but serve as a sucking and straining apparatus, for conveying to the mouth the juices on which the fly feeds.

They communicate, either directly or indirectly, through the two inner marginal tubes, with the mouth, whence they can receive a supply of saliva, to be used in moistening the object which is to yield nutriment and dissolve whatever soluble matter it contains, the resulting liquid being then conveyed along the channels to the mouth. For example, when a house fly brings its proboscis down on a lump of sugar, saliva is poured out and dissolves a little sugar, and the syrup is then sucked along the pseudo-tracheæ into the mouth, which is situated at the junction of the two labellæ. Similarly the juices of flesh, whether cooked or uncooked, can be extracted by the bluebottle. The supply of saliva is very copious, and the glands which secrete it are correspondingly large, extending right down into the abdomen. If a fly be held between the fingers so that the movements of the proboscis can be seen, there will soon be observed a clear drop of saliva collecting over the inner surface of the labellæ, and retained there partly by the aid of numerous hairs round the edges.

But there is at the same time another set of organs used in the taking of food, consisting of some fifty or sixty forked rods called "teeth," placed in a radiating

manner just round the mouth. When the labellæ are closed, or only partially open, the teeth are concealed between their folds, and cannot therefore be brought into use. But when the labellæ are opened to the fullest extent, they are used for rasping the surface of the food, thus aiding in exposing new surfaces to the action of the saliva. It follows, therefore, that repeated attacks of the teeth and the tips of the chitinous rings of the pseudo-tracheæ upon any delicate surface, must produce numberless little scratches and asperities, which will be more or less detrimental to the aspect of that surface. This, quite apart from fly-spots, *i.e.*, dabs of excrement, is a source of damage to pictures, the covers of books, or other objects the exposed surfaces of which are delicate enough to receive impressions from such engraving tools as the fly's proboscis carries. The extreme flexibility and power of movement the labellæ possess can easily be observed by holding the fly between finger and thumb, when they will be set in incessant motion, their outline continually changing as first one part and then another is bent, now up, now down. Thus the tip of the proboscis can be closely applied to any kind of surface, into the little irregularities of which the flexibility of the labellæ easily enables it to fit. Flies, *Musca domestica* in particular, seem to have the power of extracting nutriment from the most unpromising materials, witness the perseverance with which, on a hot summer's day, they keep dabbing their proboscis down upon one's coat as they course hither and thither over its surface; for it can hardly be supposed that they would so persistently keep up the practice if they found that they derived no benefit from it.

CHAPTER XII.

HOUSE FLIES AND BLUEBOTTLES—Continued.

THE description given in our last chapter of the mouth-organs of the bluebottle will not apply without considerable modification to our fifth species, *Stomoxys calcitrans.* This, it will be remembered, is the blood-sucking fly that has the annoying habit of piercing our skin in a manner which reminds us of gnats and mosquitoes. No one can look attentively at this fly without suspecting it of possible powers of annoyance: the needle-like proboscis, projecting straight forwards, like a lance ready for action, looks vicious enough, and by the weapon of which it forms the sheath, the insect can certainly make a sharp and painful puncture. Apparently, however, its powers in this direction have been somewhat exaggerated; such, at least, is my own experience, and although the puncture is irritating enough at the time, there are no painful after-effects, as in the case of gnats and mosquitoes.

With the naked eye we see in this proboscis nothing more than a black, slightly curved, rod-like organ, projecting nearly horizontally from the lower margin of the head. A hand lens shows it as a somewhat cylindrical polished rod, enlarged towards the base, and with the free end considerably more rounded and less acute than it appeared before. The compound microscope exhibits it as a highly polished, deep brownish-black body

(Fig. 63), closely covered, from the base to near the tip, with minute grooves marking it transversely; at the base these are at right angles to its length, and this direction is preserved till about the middle of the more slender part, where they begin to slope towards the tip, the inclination gradually increasing up to the place where they cease, a little before the tip. At the hinder end of this hard polished body is a funnel-shaped piece running up perpendicularly to attach the whole organ to the head. On the front edge of this are the maxillary palpi, differently shaped from those of the bluebottle, being more uniform in diameter throughout, and therefore slenderer and less club-shaped. At the tip of the proboscis are the labellæ, fringed with hairs, as in the bluebottle; but they are reduced to very small dimensions, and scarcely exceed the rod-like portion in diameter. This is all that can be seen superficially.

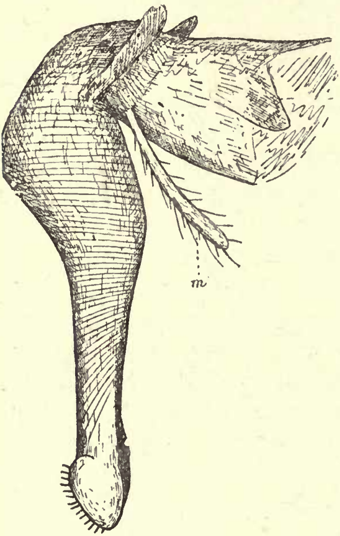


FIG. 63.—Proboscis of *Stomoxys calcitrans*. *m*, maxillary palpi.

If, however, the organ be severed from the head and pressed, it is soon discovered to be grooved, and from the groove on the upper surface shoots out a long blade, like that of a penknife, with an exceedingly sharp tip. This lancet is the weapon that does the mischief when the fly settles on one's hand for a draught of blood.

It is sufficiently strong to be able to perforate a thin garment and reach the skin beneath. Under a high power of the microscope its whole surface, except the extreme tip, is seen to be beset with excessively minute hairs.

All the five species of flies of which we have hitherto been speaking pass through practically the same series of changes in the course of their life. The long oval eggs are produced in great numbers, and are laid on the substances which are to serve as food for the larvæ. This is different in different cases. The bluebottles select flesh, either raw or cooked, and even wounds in the living animal are not exempt from their attacks. The frightful story of "Old Prue" in "Uncle Tom's Cabin" has had its counterpart in real life, and the torments of the wounded on a field of battle have sometimes been increased in this loathsome way. In the summer time no animal substance can be long exposed without being visited by these and other flesh-devouring flies; but if it is in the open air, the chief visitor is likely to be the flesh-fly, *Sarcophaga carnaria*, a voracious devourer of animal matter, which, however, rarely enters houses. It is quite different in appearance from these others, being prettily chequered with black and white. The larger house fly does not select meat, but deposits its eggs amongst stable refuse, as the larvæ feed upon horse dung, of which they eat the softer decaying parts and leave the bits of hay and straw. The smaller house fly (*H. canicularis*) selects decaying vegetable matter; but *Stomoxys*, like *M. domestica*, prefers the manure heaps.

Closely connected with the extraordinary nature of the food of the larvæ is the rapidity with which these flies pass through the earlier stages of their life. As an

influence tending towards shortness of larval life, we may no doubt reckon the fact of the great abundance of food amidst which the larvæ find themselves immediately on being hatched; they have literally nothing to do but to eat. No exertions of their own are necessary to procure food; it is all ready to hand. And, again, the condition in which the food is found—putrefaction having probably already set in—necessitates haste if the grubs are to anticipate the ordinary chemical processes of nature, and seize upon the food material while it is still in the condition of organic compounds, and before it has passed into the greater simplicity of combination which restores it to the inorganic world and renders it unfit to support animal life. The eggs, therefore, are hatched very soon after being laid, only a few hours intervening between their deposition and the appearance of larvæ. The eggs of the flesh-fly above mentioned (*Sarcophaga*) are, indeed, hatched *before* they are laid, *i.e.*, while still in the abdomen of the mother, so that they are laid as living maggots ready at once to commence the work of their life. Most of these flies, too, are gifted with extraordinary fecundity, a fact which, while it adds to the annoyance we receive from the perfect insects, at the same time considerably increases the counterbalancing benefits conferred on the world at large by the continued and extensive consumption of putrefying matter.

The eggs are of a long oval shape, opaque, and of a dull chalky colour. Great numbers are laid in a single batch; a solitary house fly, which had been enclosed in a bottle, was observed by Dr. Packard to lay 120 eggs in the course of fourteen hours. These were deposited in piles, or stacks, loosely at the bottom of the bottle. Twenty-four hours after the completion of the

laying, some had already hatched, and the rest very soon followed suit. As such a degree of fecundity was manifested when no manure was at hand, and the circumstances were therefore unfavourable, it seems probable that the number would have been exceeded in the open under natural conditions. If a little fresh horse dung be exposed at an open window during the month of August, the flies will soon discover it, and may be watched as they proceed to lay their eggs in all the little crannies they can discover.

The larvæ are all similar in appearance (Fig. 64), whitish footless grubs, known as maggots or gentles.

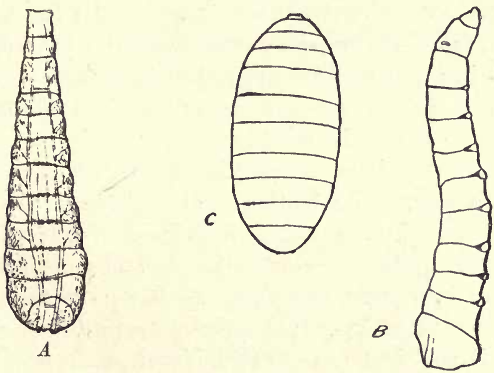


FIG. 64.—*A*, Newly hatched Larva of House fly; *B*, More advanced Larva of same; *C*, Puparium of same. (After Packard.)

Their shape is rather difficult to determine by observations on the living specimens, as the skin is soft and flexible, and they are in continual motion, contracting or relaxing their muscles, and thereby perpetually altering their form. When still, they are of a somewhat conical form, the anterior end being the smaller of the two. They subsist not merely on the juices, but on the more solid matter of the mass of corruption amongst

which they find themselves, and hence, unlike the perfect insects, are furnished with a biting apparatus, which is in the form of two strong hooks. These are cast off when the pupa stage is reached, and left behind with the pupa case on the emergence of the perfect fly. The trifling amount of locomotion necessary to the maggot is performed by muscular contortions of the body, aided by the hook-like jaws, and by rows of tiny hooks at the junctions of the segments. The larval life, as we have already said, is but short; that of the house fly, for example, lasts about a week, during which time the maggot is said to change its skin twice, altering its form to some extent on each occasion. By the end of this time it is full-grown, and passes into the pupa condition, which in about another week gives place to the perfect form. The larvæ are apparently tenacious of life, and can continue to exist even under very unfavourable conditions. Thus it is recorded in the French *Naturaliste* of the maggots of a bluebottle, that they had been put into an aquarium to serve as food for the newts, and two days afterwards they were still alive, and some had even changed into pupæ, though at the bottom of the water. They are very dependent on temperature, and unless there is sufficient warmth their development is delayed, and they become more or less dormant; hence all specimens that are in the larval or pupal condition at the approach of winter have their further development stopped, and remain in a torpid condition till the returning warmth of spring enables them to complete their cycle of changes.

The pupæ are extremely peculiar. With most insects, it is customary for the pupal condition to be assumed by means of a casting of the last larval skin. Such, however, is not the case with these flies; but

instead, the last larval skin simply hardens and is not shed at all, the true pupa being formed inside it. In most cases, the larva burrows into the ground before accomplishing this change. The hardening process appears to be completed very suddenly; the skin contracts, especially in length, and becomes hard, brittle, and dark coloured, until what was a few minutes before a soft, wriggling, conical maggot, becomes a short cylindrical body with rounded ends, enveloped in a hard reddish-brown skin, faintly marked with a succession of grooved rings transversely to its length, and utterly incapable of the slightest movement. Evidently, therefore, this so-called pupa is not strictly comparable to the chrysalis of a butterfly or moth, notwithstanding some superficial resemblance. Each, it is true, is covered by a hard reddish-brown skin; but that of the moth is the true pupa skin, whereas that of the fly is not a pupal skin at all, but the last larval skin, and corresponds to the thin, crumpled, and collapsed skin that is left at the tail end of the moth's chrysalis. The true pupa skin of the fly is to be found inside, in the shape of a thin membrane in which the contained pupa is enveloped. Such a pupa is described as *coarctate*, and the brown skin is called the *puparium*.

When the fly is ready to issue from the pupa-case, it is found to be furnished with a large membranous protuberance on the head between the eyes. This is the outer surface of a hollow sac, which is capable of great distension, and is used in pushing off the top of the barrel-shaped pupa case, which separates along the line of one of the circular grooves. By muscular contractions the fluids of the body are forced into this sac, distending it, and causing it in turn to press against and ultimately force off the lid, thus liberating the fly. In Fig. 65 the

insect is shown just after the lid had been forced off, with its body still enclosed within the lower part of the pupa case, and the distension of the frontal sac is still at its height. The fly soon wriggles out of the case, and, while its body is still soft and pale, runs about with its wings in a crumpled and baggy condition; as it thus runs along, the membranous sac on the head alternately dilates and contracts, being connected with the breathing-tubes. But as the skin gradually hardens and the wings become fully expanded, the movements of this sac become less perceptible, and finally, when the hardening process is completed, and the fly is ready for flight, all power of dilatation is lost.

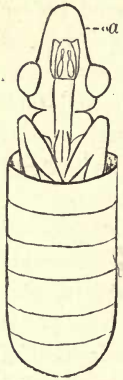


FIG. 65.—Fly in Puparium, lid removed. *a*, Frontal sac.

It is impossible to speak definitely with regard to the duration of the life of the perfect fly; but it would appear to be longer than that of the larva and pupa, except when these exist through the winter. Bluebottles are often caught with very ragged edges to their wings, and with their proper proportion of hairs much reduced, both of which mutilations seem to imply a good deal of knocking about in the world. In addition to this, bluebottles, at least, hybernate, and are thus able to exist from one year into the next, though probably only a very small proportion of the specimens of a given season survive in this way. During the winter they stow themselves away in the most perfect concealment in unsuspected corners and crevices, from which, however, an unexpectedly warm and sunny day in spring will at once entice them. Most people have probably noticed the sudden appearance of flies on such occasions, and their equally sudden and complete

disappearance as soon as the weather becomes cold again, when they return to their hiding-places. In cold weather they appear to be partly paralysed, and have scarcely any power over their wings, and but little over their legs. They are truly creatures of the sunshine.

Like many other insects, the two house flies are subject to the attacks of a parasitic fungus which destroys great numbers of them, especially towards the end of autumn. We sometimes see the corpses of such as have met this fate glued to the window-panes in the attitude of life, with legs widely spread and wings raised, as if in preparation for flight, but with a white halo on the glass all round them, and with bodies pale, unhealthy-looking, and distended. The spores of the fungus, which are excessively minute and are present in the air, are carried against the fly's body; and such as strike its under surface may become adherent, when each spore sends out a long tubular projection which penetrates the skin and enters the body. Once here, its host's doom is certain, for it meets with suitable nourishment in the shape of the fluids of the fly's body, by aid of which it will speedily propagate itself until its victim, drained of its life support, finally succumbs. The thread-like tube first produces a series of detached rounded bodies, something like the cells of the yeast plant. These cells, which have an indefinite power of self-multiplication, are carried by the blood to all parts of the body, and thus the disease spreads. They, in their turn, give rise to a number of branching tubular threads, similar to those of the earlier stage, which in process of time penetrate the skin. Each thread which thus makes its appearance outside gives rise to a sort of head, which contains spores like those with which the series started. These are cast off with considerable force, and multitudes

of them no doubt perish, while others are ultimately wafted against the bodies of other flies to deal destruction among them as among their predecessors. The particular species of fungus which makes havoc with the house flies is called *Empusa muscæ*, and is one of a group which are distinguished by their habit of subsisting upon living insects. The maturation of the fungus involves the death of the fly, the fluids of whose body serve as food for the parasite. Under its attack, the fly becomes gradually feebler, and finally quite unable to move, and then the viscid secretion from the pads on the feet hardens and glues the insect to the surface to which it is clinging, while the fungus spreads round it and leaves some of its spores adhering, so as to form the halo above described.

Besides the five species of which we have hitherto been speaking, there are several other *Muscidæ* that frequent our houses, though perhaps none to so great an extent as those already described. One of the commonest of the less familiar species is *Cyrtoneura stabulans*, which is at times almost abundant enough to be classed with the other five. It is a very widely distributed insect, occurring in the neighbourhood of dwellings, not only in Europe but in America, and at the Antipodes as well. As its name imports, it is frequently abundant in stable-yards. It is a robust, dirty grey insect, in size ranking next the bluebottles. The thorax is distinctly marked with four dark longitudinal streaks, consisting of the usual bare patches amongst the grey tomentum; the tip of the triangular hinder termination of the thorax is reddish, and the legs, except the tarsi, are of a clear yellowish or reddish-brown. The neuration of the wings (Fig. 66) is very similar to that of *H. canicularis*, but the chief nervures

are pale at the base. These four characteristics will probably enable the insect to be recognised. At the moment of writing, it is sharing the window-panes with the smaller house fly and a bluebottle.

The habits of this fly are apparently very varied. Its larvæ have been usually said to live on rotten fungi, but no doubt they also eat decaying vegetable matter of other kinds, and, judging by their abundance in stable-yards, apparently they devour manure as well. But that they are not confined to such diet is proved by the following observations of Mr. J. E. Fletcher: writing in October 1883, he says, "For several years I have

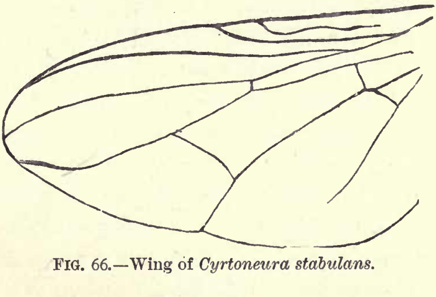


FIG. 66.—Wing of *Cyrtoneura stabulans*.

grown a patch of shallots, being uniformly successful with them until last year, when they were moderately attacked by Diptera, which, however, I was glad to find, as I was desirous of breeding them. I noticed two species of larvæ, one much larger than the other; and when the imagos appeared in the autumn and following spring, they proved to be *Cyrtoneura stabulans* and *Phorbia cepetorum*, Meade. This year about a peck of shallots were planted, which should have yielded a crop of, say, seven pecks; instead of which they yielded little more than a quarter of a peck, the rest having been utterly spoiled by larvæ of the Dipterous insects named."

As the pupæ of these insects are formed underground, no doubt in the above instance members of the autumn brood survived the winter in the pupa condition, and the ravagers of the second year were the offspring of these; hence the advisability, apart from any other reasons, of not sowing onions two years in succession on the same ground. As many of the *Muscidæ* are destructive to living plants, their larvæ either forming galls, mining in the leaves, or causing, as in the instance quoted, a rottenness of the part affected, there is nothing unusual in the above occurrence, except that an insect which is generally credited with being a dung-feeder should unite with such habits that of feeding upon living plants. But a much more remarkable change of diet has been recorded of the same insect. It has been found by Professor Riley to be an internal parasite of the so-called cotton-worm of America, its maggots feeding upon the viscera of the insect in the same way as those of the ichneumon flies. Such parasitism again is a habit of other *Muscidæ*, and the peculiarity in the present case consists simply in the abandonment of a vegetable for an animal diet, for which it is difficult to conceive the inducement.

By far the handsomest of all our household Diptera is the greenbottle, which, though extremely abundant out of doors, is only an occasional visitant indoors; it is, however, closely associated with man and his surroundings. Its body is of a most brilliant metallic golden-green colour, whence its popular name. Its scientific name is *Lucilia Cæsar;* its habits are similar to those of *Calliphora.* It attacks meat, but is more frequently seen on raw flesh than on cooked, and preferably sucks that in which decomposition has already set in. It is a great pest to fishmongers, and a piece of stale fish

is sure to be a great attraction. It also frequents excrementitious matters in large numbers. It is as prolific as the bluebottles, laying from 300 to 600 eggs, and, like them, is in its larval condition essentially a carrion-feeder. That carrion is its most natural food has been decisively shown by the experiments of M. Portchinski, a Russian entomologist, who placed eggs of three different species of flies on each of three different food substances, and carefully watched the results. The species experimented upon were the present insect, one of the bluebottles (*C. erythrocephala*), and one of the flesh-flies allied to the *Sarcophaga* already mentioned; and the foodstuffs were meat, cattle-dung, and decaying mushrooms. The eggs soon hatched, and in all three cases the maggots derived from those that had been placed on the meat throve rapidly, and soon completed their metamorphoses; while all the rest grew but slowly, and finally perished, with the exception of one batch, viz., those of *L. Cæsar*, which had fed on the cattle-dung; these, however, grew much more slowly than those of the same species that had been fed on the meat; still they survived, and finally completed their metamorphoses. All that had been placed on the rotting fungus died without exception. Carrion, therefore, is the natural food of the larvæ of the greenbottle, though they will subsist on excrement, and those of the bluebottles are still more emphatically carnivorous.

Though the greenbottles and bluebottles are so different in appearance as perfect insects, their larvæ are very similar, and in fact, as Sir John Lubbock has pointed out, the form of a larva is dependent not only upon the type of insect it is destined to produce, but also upon its environment, so that those which live under similar conditions may be expected, for that reason, to

be more or less alike, however dissimilar the perfect insects may be. This law is strikingly exemplified in several of the carrion-feeding flies, whose larvæ are sometimes almost indistinguishable, though the flies are totally unlike.

As regards adornment, *L. Cæsar* is really a splendid insect, and so far well deserves a detailed examination. But beauty is only skin-deep, and *Cæsar* is rather like a whited sepulchre; so that on the whole it is best to avoid too close contact, as its food usually betrays its disgusting nature by imparting more or less of an offensive odour to the insect. If one should gain entrance to a room and become annoying by its buzzing, and if death be in consequence decreed against it, it is well to remember that it should on no account be crushed; for if it has come direct from a meal, its digestive tube is pretty sure to be filled with a most fœtid fluid, which, when exposed, will not be slow to make its presence disagreeably manifest. And in this connection it should be noted with regard to flies in general, that if they are to be killed by crushing, it is not sufficient to crush the abdomen. The most vital part is the thorax; here are situated some of the largest parts of the nervous system; serious damage done to these nerve centres is irremediable, and death follows at once. Not so, however, with regard to the head and abdomen: the latter may be crushed, or even removed entirely, without by any means destroying life, and a fly which has received such damage to its abdomen that part of its contents protrude, will still continue to run about as though nothing had happened. The destruction or removal of the head of course puts an end to the action of the organs of sense, unless any such capability is located in the halters, but it by no means deprives the insect of the power of movement. The decapitated head,

which contains those ganglia that may be regarded as equivalent to a brain, soon ceases to show any signs of life; but the body, if touched, will for hours after decapitation respond to the stimulus by reflex movements of the legs and wings. The ganglia in the thorax, therefore, are all-important as the centres of animal life, and it is by crushing *them* that the life of the insect is most effectually and speedily destroyed. There is all the more reason for this with the *Muscidæ* than with other insects, because of the remarkable concentration of the nervous system in that family. The whole of the ganglia belonging to that part of the nerve-chain which lies behind the head have become fused into one mass, and that mass is situated in the thorax (Fig. 67); it may easily be discovered in a bluebottle by removing the skin from the upper surface of the thorax, and then cutting away the masses of muscle which are thus exposed, as well as that part of the alimentary canal which lies immediately beneath them. The nervous mass is then seen as a whitish body from which threads pass in various directions. This dissection should be performed under water.

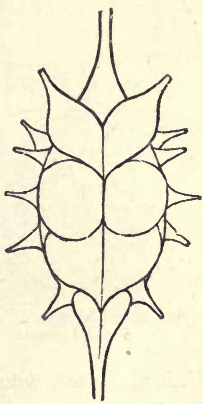


FIG. 67.—Thoracic Ganglia of Bluebottle. (After Lowne.)

There is a very pretty fly called *Pollenia rudis*, which is often common on the window panes in the spring, before *M. domestica* appears. It is about the size of the latter species, and hibernates in the house, whence its presence on the windows. It is of a shining brownish-black colour, the thorax being sprinkled with thin golden hairs in addition

to the black bristles which are scattered over the body at large. The abdomen is very pretty, but is difficult to describe, inasmuch as the distribution of colour varies with the position in which it is seen. On each segment there is a pattern of patches with zig-zag outlines, some of which appear ashy grey, and the rest deep brownish-black; but it depends entirely upon the light which of them shall appear grey and which brown. The pale tint is that of the tomentum, while the dark is the real colour of the skin, and according to the angle at which the insect is placed, the one or the other becomes more plainly visible. Thus, if the fly be turned towards the source of light, the patches marked a_2 and b_1 in Fig. 68 appear brown, and those marked a_1, b_2 pale grey; but if it be turned round in the opposite direction, the colours are reversed, and a_2 b_1 appear pale and a_1 b_2 dark.

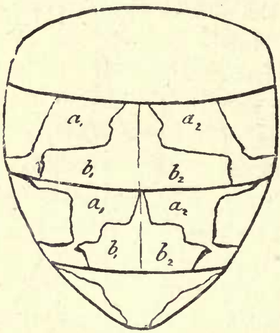


FIG. 68.—Abdomen of *Pollenia rudis*, female.

Very little is known of the earlier stages of this fly, but the perfect insect is often common, and occasionally even becomes a great annoyance. The worst instance on record is one from the United States, where the insect is called the "Cluster Fly." Professor Riley gives the following extract from a letter descriptive of the visitation which occurred at Geneva, N.Y.:—"They were at once a terror to all neat housekeepers, and from their peculiar habits a constant surprise. People soon learned to look for them everywhere—in beds, in pillow-slips, under table-covers, behind pictures, in wardrobes, nestled in bonnets and

hats, under the edge of carpets, &c. A window-casing, solidly nailed on the wall, when removed, showed a solid line of them from top to bottom. They like new houses, but are also found swarming in old unused buildings. But most of all they like a clean dark chamber, seldom used, and, if not disturbed, form in large clusters about the ceilings. Under buildings, between earth and floor, they are often found in incredible numbers."

Flies are subject to the persecutions of animal as well as vegetable parasites, some of which attack them externally and some internally. The chief external one is a reddish kind of mite (Fig. 69). These creatures may be found, principally during the summer months, on different parts of the bodies of the flies, especially on the under surface; here, in the neighbourhood of the attachments of the legs, and at the junctions of the body segments, there are plenty of places—the joints of the armour, as it were—where the skin is thin enough for the mites to pierce with their snouts. They show a good deal of enterprise in endeavouring to secure the best places—no easy matter when there are a good number of them—and when one has plunged its proboscis into the flesh, it adheres most tenaciously, and its body may be lifted up and pushed from side to side without

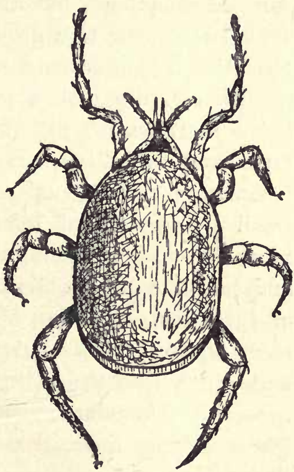


FIG. 69.—Mite Parasite on Fly. Taken from body of *Pollenia rudis*.

causing it to relax its hold. The flies, though so particular in removing from their persons the slightest trace of inanimate foreign matter, by sweeping and scraping themselves with their legs, yet submit patiently to the presence of their living burdens, even when they get into places whence they could, one would imagine, easily be removed. For example, a *Musca domestica* that has just at the moment of writing alighted on the window-pane, flew about unconcernedly with a large mite clinging to its face in such a way as one might suppose would have seriously interfered with the use of both eyes and antennæ. It did not seem, however, in the slightest degree incommoded. Another external parasite sometimes, but not so commonly, found, is an animal belonging to a group closely allied to the mites, viz., the book-scorpions or chelifers. It is a little reddish creature with a pair of great pincers in front like a scorpion, but differing in that the body does not taper away into a tail, but ends abruptly.

Amongst the internal parasites are various kinds of small hymenopterous insects allied to the ichneumon flies; and an instance is recorded of an exceedingly fine and hair-like nematoid worm, of the enormous length of three inches, having been taken from the abdomen of a house fly. M. Fourment, who records the fact, states that, notwithstanding that the parasite had caused a considerable enlargement of the body of its host, the latter did not seem in any way inconvenienced in its flight.

We have now enumerated eight species of *Muscidæ* which are more or less intimately associated with man, and which, either by reason of some peculiarity in their economy, or simply in consequence of their numerical abundance, often become a source of trouble and

annoyance in the premises we occupy, damaging our food or other property, attacking our persons, or worrying and harassing our nervous susceptibilities. Some interesting questions arise in connection with this undesirable intimacy of relation, but many more observations will be needed before any very satisfactory answers can be given to them. It is not easy to understand, for instance, why these particular species of flies, rather than any others, have elected to attach themselves to man, and to follow his fortunes, as some of them have done, all over the world. It is not that they are so different from other flies that one would necessarily expect them to behave in an exceptional way; neither in structure nor even in habits, except in this one particular, is there anything which will broadly distinguish them from allied species which do not trouble us. There is absolutely nothing that would enable a person ignorant of the species to separate, in a given assortment of flies, those that are household pests from those that are not. We get one from one group, another from another, and so on, but they do not form a compact and isolated company. Their association with man, it is true, is not so complete as that of several other insects, such as the cockroach, the clothes-moth, and the bed-bug, which spend their whole lives under the shelter of our houses, and propagate themselves generation after generation, without ever troubling themselves about the outside world. As already mentioned, it is only in the last stage of their life that, as a rule, we are annoyed by these flies; but perhaps this limitation may be regarded as making the association all the more remarkable. That as the perfect stage is reached in each succeeding generation, the instinct to betake itself to the abodes of men should regularly recur to an insect

born and bred in the open air, is, it would seem, more remarkable than that the association should be a continuous and permanent one. As the nature of the food on which they are reared necessitates, as a rule, that they should pass through their earlier stages exposed, it is rather curious that the perfect insects should not confine themselves to similar localities, but should also enter our dwellings, and often in such surprising numbers.

Nor is it, again, that they are so much more abundant than all other species, and that, therefore, mere excess of numbers causes them to be the species represented indoors: that, in other words, we simply get the overflow from outside. Of course they are abundant—this is implied in their being pests—but there are other species equally so, of which it is the rarest occurrence to find a specimen in the house. Take, for example, the case of *Sarcophaga carnaria*, the flesh-fly, which has been several times referred to already. This is an insect of most extraordinary fecundity: it is said that as many as 20,000 eggs have been found in the ovaries of a single female, and, in consequence, it is an extremely common fly; but though its habits are similar to those of the bluebottle, and it swarms round human dwellings, it is very seldom seen indoors. The facts of its distribution seem to show that it is far less dependent on man, and far more inclined to ignore his movements, than our household pests. It is an extraordinarily hardy insect, and shows wonderful powers of adaptation to circumstances. Even in the matter of food, which is often such a critical point with a larval insect, it can stand some degree of variation, feeding not merely on meat, either fresh or putrid, and wounds and ulcers on men and other animals, but even on decaying vegetable

matters, and dung as well. Even if half-starved, it will still undergo its metamorphoses, though, of course, the perfect insects will be dwarfed. Like several others, it can even withstand the action of the digestive fluids of the stomach and intestine of living vertebrate animals. Bernard introduced it artificially into the stomach of a dog, but it passed along the intestine and was voided in the usual way alive. Portchinski's similar experiment with a frog had the same result. In the case of a little song-bird, however, the larva was dead when voided, but still undigested. That so common and so hardy a European fly should be one of the most likely to follow man's lead and migrate with him to other parts of the world, would be only what was to have been expected; and yet, though the five flies mentioned at the commencement of the last chapter, together with *Cyrtoneura stabulans*, are as common in the United States as in Europe, though not indigenous there, *S. carnaria* has, according to Osten-Sacken, not yet been introduced into America, so that four centuries of European communication with the New World have not sufficed to import this abundant but independent species.

The curious observations of Portchinski have an important bearing on the subject, though perhaps they will hardly justify the conclusions he has drawn from them. He finds that carrion-feeding flies are, as a group, enormously prolific, while dung-feeding species are much less so: for example, *Calliphora*, a carrion-feeder, lays from 300 to 600 eggs; while *Musca domestica*, a dung-feeder, lays only about 120 (Fig. 70). These differences, he argues, are connected with the different conditions, as regards the struggle for existence, under which the contrasted species live. There are, according to him, comparatively few species of carrion-feeding

flies in our regions, so that they have it all to themselves, with little competition, the numerous beetles that have similar habits being said to feed quite as much on the fly-larvæ themselves as on the carrion. Their action must, from the nature of the case, be rapid, and the supply of food he regards as plentiful. All these conditions favour multiplication, and have contributed towards producing the extraordinary fecundity for which the insects are noted. There is one other

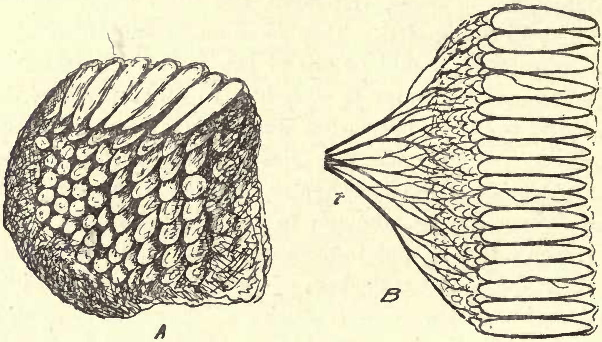


FIG. 70.—*A*, Portion of Left Ovary of Bluebottle, containing about eighty Eggs. *B*, Side View of Portion of Right Ovary, showing Distribution of Tracheæ, or Air-Tubes (*t*), to the Organ.

point which lessens the competition, viz., that the different species to some extent succeed one another during the summer in point of time (*i.e.*, in the larval form), instead of being contemporaneous. This was proved in the following way: he laid out of doors the dead bodies of small vertebrates, such as rats, birds, &c. The flies soon laid eggs upon them, and these were then collected and the maggots bred to maturity, whereby the relative numerical abundance of the species was ascertained. One of the chief results thus established was that *Cynomyia mortuorum*, an out-door

flesh-fly, was abundant in spring; but *Calliphora vomitoria*, a bluebottle, did not begin to appear till about the beginning of June, when the former species had begun to decline. Later on, the proportions were reversed, the bluebottle being in excess, and the flesh-fly scarce. Thus everything favours the fecundity of the carrion-feeders.

But with the dung-feeders the case is different. Here there is much competition, there being large numbers of dung-feeding flies, as well as beetles, which latter do not feed on the former. The supply of food, too, Portchinski regards, curiously enough, as less abundant. These are circumstances which place fecundity at a disadvantage, and hence have sprung the more moderate powers of multiplication possessed by the dung-feeding flies. But here, again, a very curious circumstance has arisen, which gives an extra advantage to the less prolific species. There is a fly which is structurally very like *M. domestica*, differing chiefly in the brighter colour of its abdomen (Fig. 71), which is of some tint of yellow or brown. Its name is *Musca corvina*, and it frequently hibernates in houses, and may therefore be reckoned amongst the household species. Notwithstanding the close resemblance between these two species in their perfect condition, as well as in that of the full-grown larvæ, there is a most extraordinary difference in the circumstances of their development. While the house fly lays 120 eggs, *M. corvina* lays only 24; but they are much larger, and hence the larval life

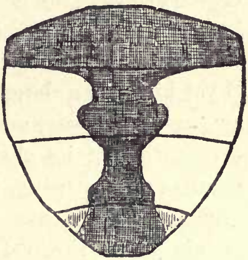


FIG. 71.—Distribution of Colour on Abdomen of *Musca corvina*. The clear parts are yellow, the shaded parts black.

is able to be shortened. This is done at the expense of one of the two transformations. *M. domestica*, as before mentioned, passes through three stages in its larval life, while *M. corvina* has only two, the second of the three being, in its case, omitted altogether. This enables it to come to maturity sooner than its relative, and hence gives it an advantage which counterbalances its low degree of fecundity. In some such way as this, Portchinski considers that more prolific flies have been weeded out by less prolific ones from amongst the dung-feeders, so that the majority are now of the less prolific type. But *M. domestica*, with a degree of fecundity which, though low as compared with the carrion-feeders, is yet high for a dung-feeder, is apparently an exception amongst the latter, and herein M. Portchinski finds the explanation of its close association with mankind, the bond of union being, in fact, in this particular species probably closer than in any other, for the house fly is said to be rarely found far from human dwellings. According to the above theory, the house fly has sought the protection and additional resources of man's society to aid it in its struggles with less prolific insects, which, by their shorter larval life, would otherwise have hurried it out of existence. Whatever may be thought of these speculations, and it would obviously not be difficult to raise objections to them, still the observations on which they are based have revealed some very curious facts which require to be accounted for in some way or other, and which invest with special interest the history of the relations between insects and man. Farther researches by the same investigator show that the developmental history of an insect may depend very much upon climate, the same kind of fly developing in a different way in northern and in southern latitudes.

However exclusive the tastes of their larvæ may be, some at least of these flies seem to be almost omnivorous in their perfect stage, and therefore, possibly, food is one attraction which allures them into our houses; but then again comes the question, "Why these alone? Why do not the abundant supplies man's providence stores up become equally enticing to other closely allied forms, whose tastes and needs one would suppose to be similar?" Flies generally manage to find out the room in which the provisions happen to be placed, though the aspect of the apartment has certainly quite as much to do with the numbers that find their way thither as the mere presence of eatables. If the room be bright and sunny, the flies will swarm, while the same provisions in a dull and shady room will be almost ignored. And again, apart from the occasional intrusion of an unwelcome bluebottle making straight for the cold meat, the bringing in of meals does not usually produce any noticeable increase in the number of flies in the room; often many of those that are there seem supremely indifferent to the viands that may be displayed, and continue to amuse themselves by sporting about the windows, mirrors, picture-frames, or gas pendants. We must not forget, however, that what is not food to us may yet be so to them, and they appear to find in these various household objects some sort of nutriment, to judge from the industrious way in which, for example, they will travel over the painted window-frames, dabbing their proboscis down with as much persistence and energy as if they were making a most luxurious feast. What is it they get? Is it the varnish, or the oil with which the paint was mixed, or is it the thin film of miscellaneous matter—dirt we call it—which gradually accumulates on every exposed surface? On any of these

suppositions, one would imagine that there would be at least as much to be obtained out-of-doors as inside, and probably a good deal more.

Such species as hibernate in the house, like *Pollenia rudis*, no doubt come in for the sake of shelter from winter's cold. These gradually accumulate, instead of suddenly coming in a swarm. An instance has been recorded of two other species of the same genus swarming in the same building, to the exclusion of others, for seven successive years. The suggested explanation was that there were certain conditions which facilitated the entrance of the flies, but rendered their exit difficult.

CHAPTER XIII.

GNATS, MIDGES, AND MOSQUITOES.

UNDER these names are included a variety of small, delicately constructed flies, the very types, in the insect world, of slenderness, grace, and fragility. But fairy-like elegance of form is no guarantee of gentleness of disposition, and it is united, in the case of *some* of these insects, with a persistence and hardihood in attack, and a bloodthirstiness of nature, that make them some of the most intolerable of pests. In this country, it is true, we are now, for reasons which will appear later on, tolerably free from annoyance on their part; but as they are world-wide in distribution, ranging from the tropics to the Arctic zone, there are many less-favoured lands, in which they still exist in countless myriads, and in which their extermination would be hailed, whether justifiably or not, as an unmixed blessing. They form a sub-section of the enormously extensive order of Diptera, or two-winged flies, an order which is probably responsible for the infliction of a larger amount of suffering and annoyance upon human beings and other vertebrate animals than can be charged upon any other. At least two very distinct types of Diptera may be recognised: on the one hand, there are stout-bodied and comparatively short-legged flies, with minute and curiously-shaped antennæ, like those of the blow-fly, and on the other, slender-bodied, exceedingly long-legged

flies, with antennæ of ordinary size and of less extraordinary shape. To the former division (*Brachycera* = short-horns) are referred the house flies and allied insects discussed in the previous chapters, as well as hosts of others less familiar; while to the latter (*Nemocera* = thread-horns) belong a weak-limbed and fragile group, the daddy-longlegs or crane-flies, together with the numerous kinds of gnats, mosquitoes, midges, merry-dancers, &c. (though not the equally, or even still more, fragile May-flies or day-flies). It is with the section Nemocera, therefore, viz., the thread-horned flies, that we are now concerned.

There is amongst the members of this group a striking variety, both as to habits and life-history. Some, in their early stages, lead an active life in the water; others, of a more sluggish temperament, inhabit fungi or rotten wood; others, again, like the notorious Hessian fly, are parasitic on plants, producing gall-like excrescences within which they reside; while yet others, like the daddy-longlegs, whose larvæ are the detested "leather-jackets" of the gardener, live underground, devouring roots of plants as well as vegetable refuse. It might be expected that, with such diversity of habits, there would be correspondingly great differences of form in the adult insects. Such, however, can scarcely be said to be the case, and thus many that are superficially similar in the adult condition may have passed through their preliminary stages under totally different circumstances. This fact, coupled with the fragile and easily damaged structure, and consequent difficulty of preservation, the obscure colours, and the comparatively unmarked characters of the perfect insects, makes the nice discrimination of species a very difficult task; and it is not surprising that the popular judgment has declined

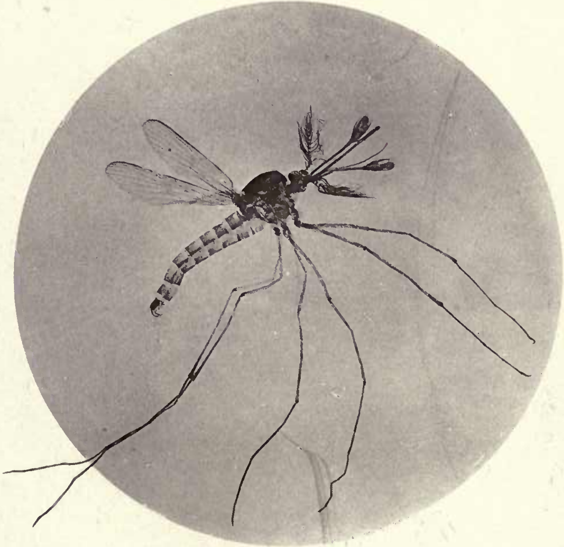
this task, and has seen in all these different creatures but varieties for which three or four names at the outside will suffice. Our first business, therefore, must be, as is usually the case in dealing with insects under their popular names, to define our terms, and to say what insects we include and what we exclude, and in what sense we use the terms "gnats, midges, and mosquitoes."

Without in the least attempting accurately to distinguish species, it may suffice to say that, when we speak of gnats and mosquitoes as household pests, we do not by any means refer to all gnat-like creatures, nor even to all which would be commonly called gnats, but only to such as belong to one particular family, the *Culicidæ*, and which, by their blood-sucking propensities, trouble mankind indoors, either in this country or elsewhere. Nor shall we draw any definite line of distinction between gnats and mosquitoes. It is often imagined that mosquitoes are creatures confined to warm climates, and have nothing to represent them in this country; but the fact is that the difference between a gnat and a mosquito is little more than one of name. To an entomologist they are practically the same thing; both are members of the same genus, *Culex*, and the difference is, at the outside, not more than that between closely allied species. It is true that the virulence of the "bite" of these creatures in tropical countries is much greater than it is here; and, when one remembers the frightful effects that are sometimes produced on the human body by these little pests, and the strenuous efforts that are made, and the elaborate precautions that are taken, whether in the way of oily unguents, of curtains and nets, or even of burying the body in the sand, to guard against their attacks, it is no doubt disappointing to discover that after all there is nothing so very remarkable

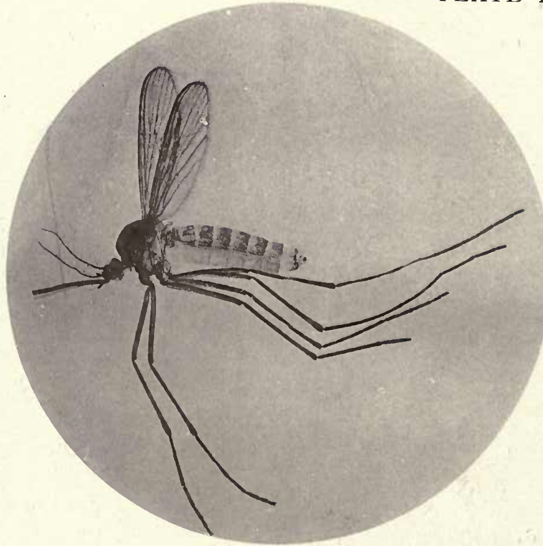
in the creatures, and that they can hardly be distinguished from insects with which we are familiar at home. Nevertheless, it is a fact which we must constantly bear in mind, that the insects to which these names are applied are to all intents and purposes identical both in structure and in life-history, and we are therefore justified in making no distinction here. Moreover, there is no doubt that, even in the matter of virulence, our own gnats vary a good deal, both according to season and to the temperament and sensitiveness of the person attacked. We must not, however, fail to note that there are other flies, belonging to different families, that are also blood-suckers, and in some cases are almost as troublesome as the true gnats and mosquitoes. This is specially the case with the small flies called *Simuliæ*, which are closely allied to the family *Culicidæ*, and are, it would appear, sometimes called mosquitoes in America. Such insects, however, are not referred to at present, and what we have to say about "gnats and mosquitoes" concerns only the family *Culicidæ*, and, in fact, the genus *Culex*.

Of the term "midges" it is somewhat more difficult to fix the application; it is indiscriminately used of at least two types of flies, quite distinct from one another, one, in most respects except persecuting powers, similar to the gnats and mosquitoes, the other very different in appearance, and at first sight more like tiny moths than flies; but it appears also to be popularly used in a loose manner for small and annoying insects of whatever kind, without any definite conception as to the actual form intended. It is obvious, therefore, that when the entomologist hears people talking vaguely of gnats and midges, it is not always easy to understand exactly what insects are being referred to.

With these preliminary precautions, and bearing in



MALE GNAT.



FEMALE GNAT, OR MOSQUITO.

Magnified about $4\frac{1}{2}$ diameters.

mind that not every small, long-legged, fragile fly is a gnat in the sense in which the word is here used, *i.e.*, a blood-sucking gnat, we may now proceed to consider first what sort of being a blood-sucking *gnat* or *mosquito* really is, referring afterwards to those which seem to be more correctly called *midges*. The photographs shown in Plate III. will give a pretty good idea of the general form of a gnat. A small head, a considerable portion of which is occupied by the compound eyes, is attached by means of a short neck to a huge globular thorax, so disproportionately large as to give the insect, when viewed sideways, a hump-backed appearance. Behind this the trunk is completed by a long, slender, cylindrical abdomen. A long, straight, beak-like appendage, carrying the mouth organs, points forward from the head, and a pair of more or less tufted, thread-like antennæ form an elegant head-gear, counterbalancing this above. From the upper part of the thorax spreads at each side a single membranous wing, exquisitely delicate, and gracefully fringed along its hinder edge; the place of the customary second pair is taken by the "poisers," long knobbed stalks, as already described in the other division of flies, but proportionately much larger than in those. From the under surface of the thorax start the three pairs of inordinately long legs, upon which, when at rest, the body is, as it were, slung up off the ground as if on springs. Though the legs consist only of the ordinary parts, yet the divisions seem at first sight to be more numerous than usual, by reason of the great proportionate length of some of the parts, and particularly of the tarsi, or feet, which in the hind pair constitute more than half the entire length of the leg, the leg itself becoming nearly three times as long as the abdomen. The insect is

beautified by the addition, on various parts of the body, of minute iridescent scales (Fig. 72), similar to those of butterflies and moths; rows of them adorn the wings, especially along the nervures.

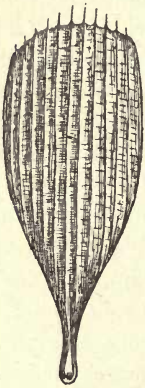


FIG. 72.—Scale of Gnat.

A marked difference appears between the sexes. The male can be distinguished by the extraordinary development of the antennæ, which, as frequently in insects of that sex, are, if one may judge from their structure, far more delicate organs of sense than those of his mate. The antennæ of the female consist of a string of cylindrical joints like long beads, each provided with a circlet of fine hairs of no very great length. Those of the male, however, while similarly constructed, have the brushes much longer and more thickly set, especially at the base, for the extreme tip is almost bare. In the photograph the hairs of the female are indistinct, through their extreme tenuity, and the charming symmetry of form and arrangement which those of the male naturally exhibit, is unfortunately destroyed, because the insects have been preserved in balsam, and it is impossible then to ensure that appendages so delicate should be spread out with all the hairs in proper position; no conception, therefore, of their great beauty can be formed from a specimen so preserved.

The greatest interest, of course, attaches to the proboscis, for herein are contained the weapons of attack. In this, again, the sexes differ greatly, and it is against the female only that the charge of blood-sucking can be substantiated. The male is an inoffensive creature, and

usually remains in his native haunts, not invading our apartments; for it must be remembered that these flies, like those treated of before, pass their early stages out of doors, and enter our houses only when fully grown. The straight cylindrical spike, projecting from the head, though itself no thicker than a hair, is a tube, or rather trough, terminated by two small fleshy lips, the dwarfed representatives of the two large folding leaves which terminate the proboscis of the blow-fly. This tube represents the labium of the normal insect's mouth, and concealed within it lie the much finer *piercing* organs; for the so-called "bite" consists really of a boring and sucking operation. Along by the upper slit of the trough lies a long bristle-shaped organ, which represents the labrum or upper lip; and of course all the rest of the mouth organs, except the palpi, lie between this and the labium, *i.e.*, in the trough of the latter. The mandibles and maxillæ, which in insects that feed on solid food are efficient biting weapons, are here replaced by four fine-pointed, needle-like bristles, the maxillæ being further barbed at the tip like a savage's spear, and the mandibles slightly broadened into a lancet-shaped tip. Besides these, another piercing bristle is found, which is an appendage of the labium itself. Thus there are no less than six boring organs, all contained within a sheath which is itself almost of hair-like fineness. The sheath itself, like so many other parts of the body, is beautifully ornamented outside with abundance of battledore-shaped scales. At its base are two short jointed organs, the maxillary palpi, representatives of the two unjointed red clubs which are such conspicuous appendages of the mouth of the blow-fly. This straight, unjointed spike is, at first sight, as different as could well be imagined from the elbowed, broad-tipped apparatus with which the

house-fly and the blow-fly sip their liquid nutriment; yet both are but extreme modifications of the same plan, the rasping and sucking elements being carried to the summit of perfection in the one case, and the boring or piercing ones in the other. Many intermediate forms may be seen, as in the drone-flies, breeze-flies, wasp-flies, and others which have no popular names, and a very interesting series showing the gradations might without much difficulty be prepared.

Now how is this collection of weapons used? The little insect drops gently and daintily down on to the spot it has selected for its attack, and the descent of so light and airy a being is likely to leave the victim unconscious of its presence, unless he has actually seen it settle. Then the proboscis is pointed downwards, and the tiny lips that form its tip pressed against the flesh. The bristles within the gutter-like sheath being then pressed together into one solid boring implement, their common tip is forced down on the flesh, and as they enter the wound, the trough in which they were lying separates from them in the middle, and becomes bent towards the insect's breast, the two little lips all the while holding on tight. The greater part of the length of the stilettos is then plunged into the victim's flesh, and the blood is drawn up the fine interstices of the composite borer. The wound, though six instruments are concerned in making it, is extremely minute.

So far, our description has concerned the proboscis of the *female* gnat or mosquito only. That of the male is somewhat different. There is still the straight, stick-like labium, but the palpi are greatly elongated, running along by the sides of the tubular proboscis as far as, or even beyond, its tip, and tufted at the end. A fine rod-like organ may be separated from the labium, but

whatever else the insect may have in this way, it does not use for sucking blood, being in fact perfectly harmless.

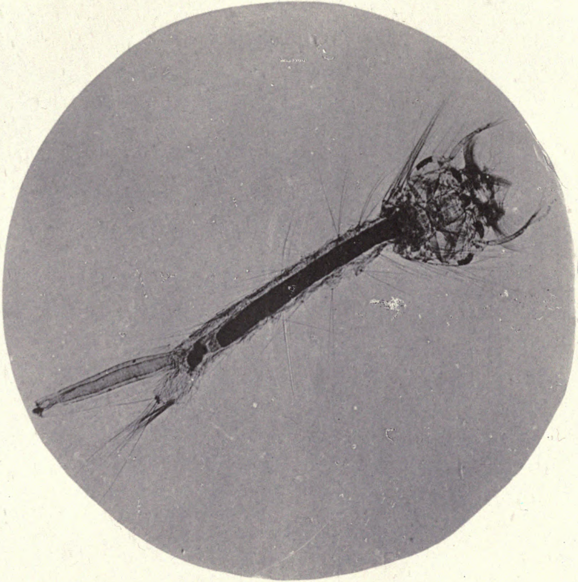
Gnats and mosquitoes are amongst that section of the "thread-horned" flies whose early life is aquatic, and a truly remarkable history is theirs. That creatures so fragile should have at any time any connection with so unstable and treacherous an element as water is indeed strange, and unquestionably large numbers perish through the mischances involved in this very association. Nevertheless, so great is their fecundity that the race runs no risk of extermination, notwithstanding the dangers that beset the path of the individual in its advance to maturity. The eggs are long oval objects, and from the time of laying they are intrusted to the water. The female, when about to lay, rests with her first pair of legs on some floating stick or leaf, or other support, the second pair gently touching the water, while the third project over its surface. Crossing these like an X, she allows an egg to pass into the angle where they meet; this is soon followed by another and another, their moist and glutinous surfaces causing them to adhere to one another with the long axis nearly perpendicular. In this way a collection of some 200 or 300 is built up into the form of a tiny raft, concave above—a sort of miniature lifeboat, so constructed that no capsizing can take place. The egg-raft once made, the maternal duties are over, and the little craft drifts rudderless away, exposed to sun and storm. This venturesome voyage, however, lasts but a few days; and then, the eggs having been from the first placed upside down in the water, the lower end of the shell is forced off, and the newly hatched grub finds itself at

once in position to take a header into the watery world in which it has to pick up its living.

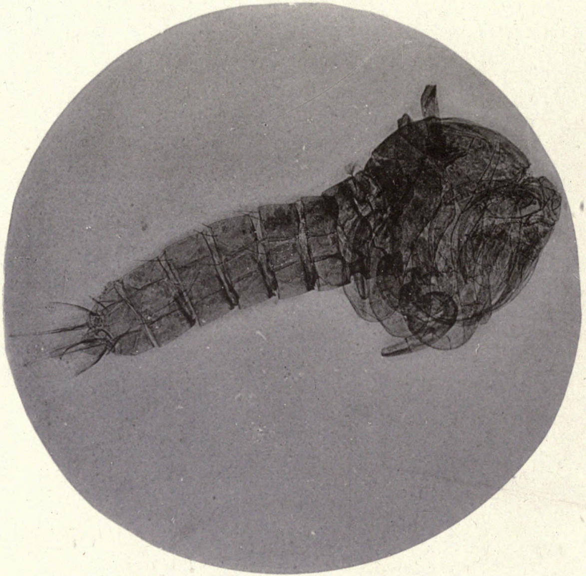
These larvæ (Plate IV.) are odd-looking objects, foreshadowing the form of the adult to a somewhat greater extent than is usually the case with those insects which pass through a complete metamorphosis. The three regions of the body are distinctly marked out, quite the reverse of what obtains amongst the "short-horned" flies, whose shapeless "maggots" we described in the preceding chapter. If we imagine the full-grown gnat's body to be bereft of all its long appendages—wings, legs, antennæ, and beak—and to be provided at intervals with tufts of hair instead, we get some idea of the outline of the larva. They move by a series of jerks, accomplished by swaying the body from side to side, and the natural position is head downwards. Though living in the water they inhale air, and hence come to the surface occasionally to breathe. The entrance to the breathing tubes is at the end of a sort of arm or branch jutting out from the hinder, *i.e.*, the upper, end of the body, and all that is necessary for taking in a fresh breath is to expose this little orifice just above the surface of the water. The larva is furnished with biting jaws, and spends a good deal of its time in devouring all sorts of rubbish and decaying matters, such as may be found in abundance in the pond it inhabits. Thus it swims about with tail most appropriately pointed to the sky, and head to the muddy bottom, where lie its chief stores of food.

It is easy to understand that thousands of these larvæ, working away in a pond on the decaying organic matter there, will do a good deal towards arresting the pollution of its waters, and gnats, therefore, in this stage of their life, may be regarded as sanitary agents, of more

PLATE IV.



LARVA OF GNAT.



PUPA OF GNAT.

Magnified about 10 diameters

or less use to society at large. It follows, then, that their extermination from any district might not be altogether an advantage, unless accompanied by other changes, such as drainage, &c.; and in estimating the influence of mosquitoes, for example, in the economy of nature, one has to set their services as scavengers over against the annoyance they cause by sucking blood. It might be a philosophical, if not very comforting, reflection for any one suffering from the persecutions of these pests, that the more mosquitoes there are, the more scavenging work must have been done in bringing them to maturity, and the more must the sanitary condition of the country round have been thereby improved! There is another curious fact connected with this stage in the life-history of these insects: when fully grown, as we have already seen, they subsist only on liquid food, their mouth organs being excellently fitted for taking in liquids, while they would find it absolutely impossible to make any use of solid food. But in this earlier stage, the conditions are reversed; solid food is the order of the day (though plentifully steeped in water, it is true), and no sucking apparatus exists, the mouth being armed with biting jaws instead.

The change, however, is not suddenly made from the one style to the other. There intervenes a condition in which the insect takes no food at all, either solid or liquid, having no available mouth; for, when several moultings of the jerky larva have taken place, it makes another change of skin, which results in an entire upsetting of all its arrangements. After this moult it appears as a kind of animated "comma," with a big head and a curved tail (Plate IV.).

The apparent head is really head, thorax, beak, antennæ, limbs, and wings of the perfect insect, all bound

together under a thin skin, sufficiently transparent for the individual parts to be traced from without, as shown in the photograph; the "tail" is, of course, the abdomen, and it is terminated by a couple of broad leaf-like paddles (Fig. 73) of exquisite structure, which form a sort

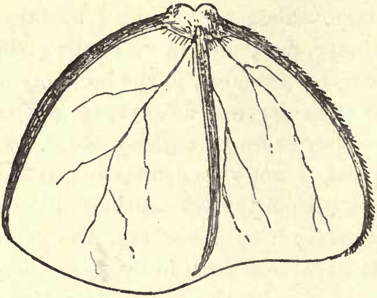


FIG. 73.—Terminal paddle or leaflet of pupa of a species of Gnat (*Corethra plumicornis*).

of sculling apparatus. It no longer jerks about head downwards, but, turning a somersault, passes the next stage of its life right way up, notwithstanding its apparently top-heavy shape. Conformably with the altered position, though whether as cause or consequence it is not easy to say, the opening to the breathingorgans is now on the thorax. Two horn-like projections (Fig. 74) are here seen, which are the prolonged lips of the spiracles. Into these is taken, by periodical visits to the surface, whatever air may be necessary for breathing purposes; such

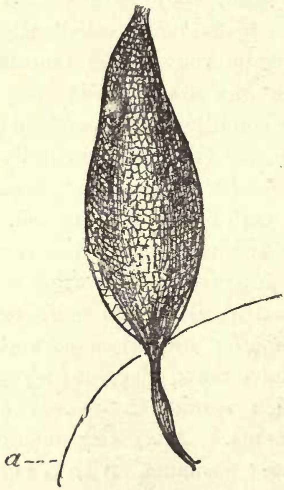


FIG. 74.—Spiracular horn of same Gnat. *a*, Outline of thorax.

visits are, however, by no means frequent, the insect

being capable of enduring prolonged submergence without inconvenience. The pupa is as capable of active exertions as was the larva, and in fact is freely locomotive, though it takes no food. This is a most exceptional circumstance amongst insects with a complete metamorphosis. Nothing, moreover, could be in stronger contrast to the style of life of the "short-horned" flies than that of this roving gnat pupa. It will be remembered that the blow-fly, which may be taken as a type of the "short-horns," when about to become a pupa, does not cast its skin, but becomes a barrel-shaped, absolutely motionless body, by the hardening of the last larval coat, whereas the gnat or mosquito *does* cast its skin to become a pupa, and that pupa is a lively wriggling creature, free to wander whither it chooses, though no more capable of feeding itself than the aforesaid barrel.

When the time for the emergence of the perfect insect arrives, which will be about a month after the hatching of the eggs, the pupa ascends to the surface, and tipping up its tail, lies in a nearly horizontal position with the back of the thorax just above the water. The skin now splits, and the fly gradually extricates itself, of course in a limp condition, and incapable of flight till its wings are dried and stiffened. The empty shell of the pupa gives it foothold till it is strong enough to spread its wings and mount into the air for the first time in its life. The occasion of the transformation from pupa to fly is evidently the supreme moment in the gnat's career, and the risks involved are considerable. Not merely is it still exposed, as it has been hitherto, to the jaws of hungry fish or predaceous water insects, but there are also chances of wind and weather that may prove fatal. However, vast swarms escape these perils

and rise into the air, where new dangers await them in the form of cobwebs and insectivorous birds, to say nothing of human beings.

We have now followed our gnat or mosquito through a complete cycle of changes, and have thus seen that it is essentially an insect not of the house but of the pond, the marsh, and the swamp, whence it follows that blook-sucking is a practice that can but occasionally be indulged in, and it seems probable that great numbers of gnats perish without ever tasting such food at all, and that in fact the habit is an acquired one, and not really essential to their existence. If this be so, it is all the more remarkable when taken in conjunction with the extraordinary perfection of the blood-sucking apparatus, and the problem of their economy is as difficult to solve as that of fleas on the seashore far from human habitations. Gnats, however, seem to be quite ready to drink the juices of flowers if they cannot get blood, and several observers have chronicled their fondness for honey. But still this will scarcely explain the presence of needle-like piercers amongst the mouth organs, since such instruments would not be necessary to get at the nectar of flowers.

In the days when every house had its water-butt, and when stagnant ponds abounded on every side, often in close proximity to human dwellings, the conditions were so much the more favourable for the multiplication of gnats; and wherever such conditions now obtain, the insects are still likely to be both numerous and troublesome. But the extensive abolition of the water-butt, the introduction of closed and indoor cisterns, and the better drainage of the land, have all tended to throw hindrances in the way of the *Culicidæ*, and have helped to reduce their numbers in our own country, whatever

may be the case elsewhere. There is evidence enough of this in literature. Enormous swarms of gnats, of one kind or another, seem formerly to have been a not unusual experience, though such a thing now scarcely ever occurs here. The poet Spenser, for example, mentions as a familiar sight "a swarm of Gnats at eventide" that "out of the fennes of Allan doe arise,"

> "Whiles in the air their clust'ring army flies,
> That as a cloud doth seem to dim the skies;"

and that *Culices* are intended seems certain, since they persecute man and beast,

> "Till the fierce northern wind with blust'ring blast
> Doth blow them quite away, and in the ocean cast."

There are several records of swarms that have looked in the distance like clouds of smoke, and have consequently given rise to an alarm of fire, as was the case at Salisbury Cathedral in 1736. According to Professor Riley, the northern mosquitoes of America pass the winter in the perfect state, hybernating in a semi-torpid condition; and a writer in *Insect Life* describes an enormous congregation of them as having been found hybernating in the corner of a cellar. This habit does not appear to hold good in all parts of the world.

A very peculiar connection between human beings and mosquitoes has been made out in recent years. It is well known that there is a class of worm-like creatures differing from the earth-worm and other similar animals in not having the body divided into a series of rings, that inhabit various parts of the bodies of vertebrate and other animals. Man is subject to the attacks of several parasites of this sort, and shares them with other animals, *i.e.*, the parasites pass through their early life in the

body of one host, and their later life in that of another. Numerous experiments and investigations, by Dr. Manson and others, seem to have proved that such a connection exists between man and a particular kind, or some few kinds, of mosquito. The parasite is called *Filaria sanguinis hominis* (the thread-worm of the blood of man). The adult female of this creature inhabits the lymphatic glands of man, and is the cause of the curious and repulsive disease called elephantiasis, and of kindred maladies. Embryos produced from these sexually mature forms, pass from the lymphatic system into the blood of man, and circulate with it, causing in this stage certain kidney diseases. No forms intermediate between these two have been found in man, and it is therefore evident that the intervening stages of the life of the parasite, whatever they may be, are spent elsewhere. From the blood of man, the embryos pass into the body of the mosquito as it sucks its victim. Only a few of these seem to be digested with the blood; the rest escape from the mosquito's digestive tube, and establish themselves in its thorax, at the same time undergoing a change of form indicative of an advance in development. Thus far the history of the parasite has been traced, but exactly what happens afterwards is still to some extent a mystery. The mosquito infested with *Filariæ* appears soon to die, the parasite apparently subsisting on the contents of its thorax. It has been thought that the mosquito's body falling into the water on its death, the parasites escape and pass a free existence for a time, being after a while re-introduced into a human host by the drinking of the water that contains them. In investigating these facts, Dr. Manson got a Chinaman whose blood was known to contain *Filariæ*, to sleep in a small curtained chamber, placed in a larger

room in which mosquitoes were flying. The door of the "mosquito house" having been left open for some hours after the man had gone to sleep, was then closed, and the mosquitoes which had entered were thus entrapped. These were found in the morning clinging to the netting, gorged with blood, and were carefully collected day by day, and preserved; some were examined under the microscope at once, others not until after an interval, so as to secure a later stage of the parasite; in this way, by the examination of large numbers of the insects, after intervals of different length, the fate of the swallowed *Filariæ* was at length made out up to the point indicated above.

One of the most curious of the annoyances that have been recorded as occasioned by gnats was illustrated in some specimens exhibited at a meeting of the Bristol Naturalists' Society in 1878. Mr. J. W. Clarke showed some sheets of writing paper from Sweden, which formed part of a large consignment that had been greatly injured during the process of manufacture through a swarm of gnats having got mixed up with the pulp. The remains of the flies were to be seen in the material of the paper, and some specimens were so perfect as to be easily identified as a *Culex*, and all seemed to belong to the same species. Another record is made of a centipede similarly preserved in paper, and no doubt paper manufacturers could supply many others, though perhaps few on so extensive a scale as that alluded to above.

It is difficult for a stay-at-home Englishman, used only to the minor inconveniences caused by insects in this highly denaturalised country, to conceive the horror with which gnats and mosquitoes are viewed in those more primitive regions in which they still exist in

incredible multitudes, and to realise the terrible sufferings they are answerable for; he is inclined to treat the whole matter almost as a joke, and to laugh at the violence of the execrations which have been heaped on the heads of such insignificant offenders. But there can be no question that the plague has been, and is still, in many parts of the world, a most real and serious one, and experience shows that the descriptions travellers have given of the numbers of the insects, and the pain and disfigurement caused by their attacks, highly coloured though they often seem, may yet be accepted as having a solid foundation in fact. The exact effect of a gnat or mosquito bite, however, upon the human body, varies with the species of insect which produces the wound, with the sensitiveness and temperament of the individual attacked, and with surrounding circumstances. On the borders of the great rivers of the Brazilian forest, where mosquitoes are probably as troublesome as anywhere in the world, the effect is quite different upon Europeans and natives. According to Humboldt, who paid great attention to the subject when he was in the region of the Upper Orinoco, blisters and swelling are not produced upon the skin of the natives, *i.e.*, the copper-coloured Indians, though such results follow in the case of the white man, new settlers being much more severely dealt with than old residents. Speaking of a white man who had had "his twenty years of mosquitoes," he says, "Every sting leaving a small darkish-brown point, his legs were so speckled that it was difficult to recognise the whiteness of his skin through the spots of coagulated blood." That, notwithstanding their immunity from the above secondary effects, the natives still suffer acutely, is manifest from the numerous and energetic devices they adopt to free

themselves from the plague, as well as from the extent to which the mosquitoes form a staple subject of conversation. Elevated platforms have been resorted to as retiring places, since the flies are most numerous near the ground, the greater number not rising above fifteen or twenty feet; a calico tent, suspended from the branches of trees when in the forest, is another device, while indoors there are the well-known nets and curtains. Humboldt speaks of his workmen as vigorously slapping one another's bare backs to drive away the tormenting insects, and as getting so used to the action that they sometimes slapped themselves in their sleep; some rubbed the wounds on their comrades' backs with rough bark (!) or again, the women patiently set themselves to pick out from the pustules the drops of coagulated blood. "How are you with regard to the mosquitoes?" was a common form of salutation; while to the native mind, the absence of mosquitoes formed the highest conception of the bliss of heaven. "How comfortable must people be in the moon," said an Indian to his European teacher, "she looks so beautiful and so clear, that she must be free from mosquitoes!"

Dr. A. R. Wallace, visiting the same region, says: "Immediately after sunset they poured upon us in swarms, so that we found them unbearable, and were obliged to rush into our sleeping-rooms, which we had kept carefully closed. Here we had some respite for a time, but they soon found their way in at the cracks and keyholes, and made us very restless and uncomfortable all the rest of the night." And so far from getting used to them: "After a few days' residence we found them more tormenting than ever, rendering it quite impossible for us to sit down to write or read after sunset." The people used dried cow-dung burnt at their doors to

keep away the insects, and this seemed the most effectual remedy, so that by adopting it, and walking about at the same time, the explorer managed to "pass an hour pretty comfortably." Mr. H. W. Bates, speaking of Fonte Boa, also in the same region, says that, "in addition to its other amenities, it has the reputation throughout the country of being the headquarters of mosquitoes, and it fully deserves the title. They are more annoying in the hours by day than by night, for they swarm in the dark and damp rooms, keeping in the daytime near the floor, and settling by half-dozens together on the legs. At night the calico tent is a sufficient protection, but this is obliged to be folded every morning, and in letting it down before sunset great care is required to prevent even *one* or *two* of the tormentors from stealing in beneath, their insatiable thirst for blood, and pungent sting, making *these* enough to spoil all comfort." From these extracts we see that the experience of the traveller in South America is by no means uniform, and this partly results from there being several distinct species of flies concerned in these attacks, some inhabiting one stream and some another, according to the character of the water, and having also their time of flight at different hours of the day and night. These peculiarities were particularly noticed by Humboldt.

Mungo Park considered that crocodiles were but of little account to the traveller in Africa, "when compared with the amazing swarms of mosquitoes, which rise from the swamps and creeks in such numbers as to harass even the most torpid of the natives." With his clothes almost worn to rags, he was ill-prepared to resist their attacks, and frequently, therefore, passed the night walking backwards and forwards, fanning himself with

his hat, perpetual motion being necessary to keep them at bay. Linné testified to their extraordinary abundance in Lapland, where smoke and grease were in his time, as they probably are still, the best preventives known. And in recent years, Nordenskjöld and others have recorded meeting with enormous swarms in high Arctic latitudes, in which regions, indeed, it is not only *Culices* that exist in myriads, but other *Diptera* as well. For instance, Dr. F. A. Walker, speaking of a visit to Iceland, mentions not only that bluebottles were to be found in great numbers on rotting fish everywhere, but especially that the little black flies that frequent seaweed on the sand flew in multitudes on board the steamer, blackening the windows of the deck-saloon. Dr. Clarke, travelling in South Russia, tells a pitiful tale of the persecutions to which he was subjected in passing through a morass which teemed with mosquitoes to such an extent that a lamp which was lit in a closed carriage was soon extinguished by the swarms that flew into it.

As may be imagined from their habits and life-history, mosquitoes are not equally distributed in the countries in which they occur; in low-lying, marshy districts they are most abundant, but as one recedes from the water, or reaches greater elevations, they become less numerous. They attack not only human beings, but also cattle, and hence the proximity of the latter in places much infested may sometimes give relief to men; on the other hand, they have often been noticed accompanying cattle on their return from marshy pastures, clustering round them, and thus becoming ultimately introduced into houses. It has been said that they object to the strong smell of the alligator, but if this be so, they can overcome their dislike when there is a chance of a draught of human blood, for Humboldt relates that, while

dissecting a large alligator, eleven feet long, the odour of which infected all the surrounding atmosphere, he and his assistants were fearfully stung. From the method of life of the mosquito, especially in its early stages, it is clear that it would be next to impossible to transport them accidentally, except as perfect insects, from one country to another, across large tracts of ocean; and the reports that are sometimes spread of mosquitoes appearing in hotels in this country frequented by Americans need to be received with great caution. Probably, in most instances, investigation would show that they were simply English gnats rather more virulent than usual, which had been propagated in some neighbouring cistern or pond.

Opinions have differed as to the cause of the swelling and pain resulting from a gnat or mosquito bite. Some have maintained, in accordance with what has always been the popular belief, that effects of such magnitude could not be produced without the introduction of a poisonous fluid, though they have failed to show that any apparatus exists which would be capable of completely fulfilling such a function. Though this poisonous fluid is itself conjectural, a purpose has been assigned to it, viz., that of rendering the blood more liquid, so that it may the more easily be sucked up. And that some such function would have to be assumed is tolerably certain, since the poison could hardly be regarded merely as an implement of offence, and consequently an advantage to its possessor. It seems scarcely open to question that, apart from some such function for the poison as above, the insects could far more easily obtain the blood they covet, and far less precautions would be taken against them, if they did not produce any painful results, and thus rouse the hostility of their victims; and that,

therefore, from that point of view, a poison could not be an advantage. If, therefore, a poison exists, its function must undoubtedly be, to facilitate the drawing of the blood, and not to serve as a weapon.

Influenced by the anatomical difficulties above mentioned, other observers have maintained that no poisonous fluid is injected, but that the laceration of tissues produced by the six minute, acutely pointed, and in some cases barbed, organs which constitute the borer, is sufficient to account for the inflammation and itching. This hypothesis, again, is not without objection. It would appear that the insect sometimes experiences difficulty in getting at the blood it desires, for deep perforations of the skin may be made without drawing blood, and then no swelling occurs, and little pain is felt: this certainly appears a formidable difficulty in the way of the latter explanation. Mr. G. Dimmock, one of the most recent experimenters with *Culices*, forcibly says: "I am convinced that there is use made of a poisonous saliva, for when biting, if the mosquito fails to draw blood, which it often does on parts of the back of my hand, it may have inserted its proboscis nearly full length in from one to six directions in the same place, and withdrawn it again; indeed, it may have inserted its proboscis, as often occurs, in extremely sensitive parts; yet in such cases, if no blood be drawn, no more effect is produced upon my skin than is produced by the prick of a sharp needle; a red point appears, only to disappear in a few hours. Certainly there has been as much tearing of tissues in such a case as above mentioned as there is when the gnat settles on a place richer in blood, and with a single probing draws its fill." He remarks also that "the poisonous effect on me, as proved by numerous experiments, is in direct

proportion to the length of time which the gnat has occupied in actually drawing blood," and argues, perhaps somewhat inconsequently, that this indicates the constant outpouring of some sort of poisonous fluid during the blood-sucking process. But notwithstanding this, he was unable to detect any channel for the conveyance of poison into the wound. And, moreover, it is difficult to conceive of a double flow of liquid—poison downwards and blood upwards — as taking place simultaneously within the narrow compass of the proboscis of a gnat or mosquito. Or, again, if the movements were not simultaneous, but a downflow of poison were followed by an updraught of blood, it would seem that the greater part of the poison would be sucked out of the wound almost as soon as it was instilled, and that, therefore, it could hardly exercise much influence upon surrounding tissues. Humboldt, who was a firm believer in the poisonous nature of the bite, considered this sucking out of the poison to be the explanation of the painlessness of some wounds. His experience was almost the reverse of that of Mr. Dimmock, as detailed above. He affirmed that if the insect were allowed to suck to satiety, no swelling took place, and no pain was left behind, and considered that when pain was produced it resulted from the hasty interruption of the process of sucking, since then the last infused poison would not be able to be withdrawn. He experimented with one of the most virulent species, allowing it gently to settle on the back of his hand, and reports of it: "I observed that the pain, though violent in the beginning, diminishes in proportion as the insect continues to suck, and ceases altogether when it voluntarily flies away." The following experiment, however, seems to throw some doubt on the poison theory altogether. He says, "I wounded

my skin with a pin, and rubbed the pricks with bruised mosquitoes, and no swelling ensued." On the whole, therefore, it must be admitted that great difficulties beset both of the two hypotheses that have been commonly advocated in explanation of the swelling and pain consequent on the bite. Of course similar remarks would apply in the case of both bugs and fleas.

There seem to be chiefly two species of true gnats that infest houses in this country, which are named *Culex annulatus* and *ciliaris.* The former has pretty spotted wings, but must not be confounded with another spotted-winged gnat-like fly (Fig. 75), which is frequently found in windows, and is generally called the "Window Gnat" (*Rhyphus fenestralis*). The specific name *fenestralis* (from Latin *fenestra*, a window) was given to it in consequence of its usual habit of flitting about windows. It belongs, however, to a different family, and its habits and life-history are totally unlike those of the true *Culices.* Its larva is terrestrial, not aquatic, and lives in dung. *Culex ciliaris*, specially known as the "house gnat," is a reddish-brown insect, with greyish wings.

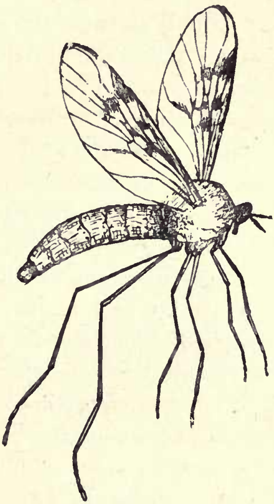


Fig. 75.—Window Gnat (*Rhyphus fenestralis*).

The *Culices*, or true gnats and mosquitoes, are not the only "thread-horned" flies that trouble mankind by sucking blood, though they are usually the chief; it is

difficult, however, to give definite popular names for the other species. The word "midge" is perhaps most commonly used as a general term for them, though it is also employed for insects of similar structure, but of less annoying habits. To the genera *Simulium* and *Ceratopogon* belong some of the most annoying of these persecuting midges; and some of the former become occasionally almost as bad a plague as the mosquitoes proper.

The *Simulia* are also known as "sand-flies," and in America, where they have occasioned great annoyance and trouble amongst the cattle, they are called "Turkey Gnats" and "Buffalo Gnats." They are small, dark-coloured insects, of a less fragile nature than the *Culices*, but still "thread-horned," and not, therefore, to be confounded with any of the "short-horns," such as the great, stout-bodied "breeze-flies," which are also terribly bad stingers. The flies have the peculiar habit of emerging from the chrysalis beneath the surface of the water.

The *Ceratopogon* which is sometimes troublesome in this country is a minute, greyish-brown insect. It is sometimes abundant in marshes and fens, where the females are very annoying.

But besides these, many other insects are called midges, though they are not troublesome. There are, for example, first, the *Chironomi* or Plumed Gnats, the larvæ of one species of which are the grotesquely wriggling, red worm-like creatures, found in ponds and water-butts, and called "blood-worms." These are more uniformly cylindrical than the larvæ of the *Culices*, and, besides wriggling about in the water, they construct amongst the mud at the bottom, tubes composed of particles of decayed leaves, fastened together with silken threads. The pupa, which is similar in shape to that of the *Culices*, and has an enormous fore-part, may be distinguished by the pair of

exquisite, white, plume-like tufts that project from the sides of that part of the body. Each consists of five hairs, which are delicately fringed, so that the whole makes a large rosette. The pupa usually lies at the bottom helplessly, though it can swim if obliged. A few hours before becoming a perfect insect it mounts to the surface to prepare for the change. The perfect insects are called "Plumed Gnats," because of their beautiful antennæ, which are even more deeply feathered than those of the *Culices*. They have no long beak, and are not adorned with scales like the true gnats. These *Chironomi* form in the air dancing swarms, which usually consist chiefly of males. Then there are the "Winter Midges" (*Trichocera*), which form little hovering swarms on bright days during winter and spring. These again are quite different from the gnats, and belong to the daddy-longlegs group. The last "midges" to which we shall refer are the family called *Psychodidæ*, most exquisite, though minute creatures (Fig. 76), some of which are commonly found in houses, on the walls, or running in little zigzags up and down the windows. They, too, are "thread-horns," but can be easily distinguished from the others by the peculiar shape and adornment of the wings. These are lancet-shaped, and are thickly covered with hairs, often so distributed as to form a pretty pattern, and this, coupled with the fact that they rest with wings not crossed over their backs as gnats do, but spread out and sloping backwards at their sides, causes them to look like tiny moths. They are harmless little creatures, and their larvæ live in dung.

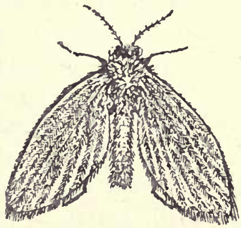


FIG. 76.—Midge (*Psychoda*).

CHAPTER XIV.

THE COMMON FLEA.

Notwithstanding his elevated position in the animal creation, man is no more exempt—humiliating though the confession may be—from the attacks of personal parasites than other animals; but of the various species that link their fortunes with his, and subsist upon his person, fleas seem less dependent than any others upon uncleanly conditions and habits of personal neglect on the part of their host, and hence they are not restricted to the lower strata of society, but become a universal nuisance. The ever-present desire to exterminate them, no doubt, operates powerfully against their being minutely studied, and hence very little seems to be generally known about their structure, habits, and life history beyond what painful experience teaches. And yet they are really extremely curious creatures; and were it not for the popular prejudice against them, they would, no doubt, attract the attention they deserve. It is no exaggeration to speak of them as zoological oddities. There are many different kinds besides that particular species that infests man. They have been observed on various mammals, especially small ones with thick fur or hair, such as moles, shrews, squirrels, mice, rats, dormice, hares, and rabbits, as well as on dogs and cats. Many birds also are infested by true fleas, in addition to their own proper parasites, the bird-lice. The species

which attack these different hosts seem to be distinct, each animal, as a rule, supporting its own special parasite, but they resemble one another so closely that they form a perfectly natural family, which is called *Pulicidæ*, from the principal genus *Pulex.* On the other hand, in their most characteristic peculiarities, they are utterly unlike any other insects, and hence have been a great puzzle to systematists. It is not easy to find a suitable corner for them in our schemes of classification, and many have got over the difficulty by placing them in an order by themselves, which, from the apparent absence of wings, has been called Aphaniptera (without distinct wings). Others have, however, seen in them some affinities to the two-winged flies, or Diptera, and have located them somewhere in that order; but here again there has not been unanimity, and some have placed them at the end, while others have inserted them in the body of the order, following the *Mycetophilidæ*, a family of small flies which possess considerable jumping power, and live gregariously amongst decaying vegetable matter, or in fungi, dung, &c. That their affinities are strongest with the Diptera is now generally recognised, and they are therefore regarded as a sort of apterous flies, which have addicted themselves to parasitic habits. The reasons for this opinion will become evident as we proceed.

Having premised thus much as to the zoological position of the group, we may now endeavour to get a clear notion of the structure of *Pulex irritans* (Fig. 77), the common human flea, so called, and afterwards deal with its life history. In the shape of their body, fleas are quite exceptional; it is flattened from side to side, so that when the insect is standing upright its greatest diameter is the vertical one. This form of body is called "compressed"; it is exactly the

reverse of what obtains in that other nocturnal pest, the bed-bug, whose body is flattened in the vertical direction, and whose greatest diameter is the transverse. This shape of body is called "depressed." Certain fishes present similar extremes of structure: thus a skate is depressed, but a plaice or sole compressed. The flea's body is covered with a hard, slippery, reddish-

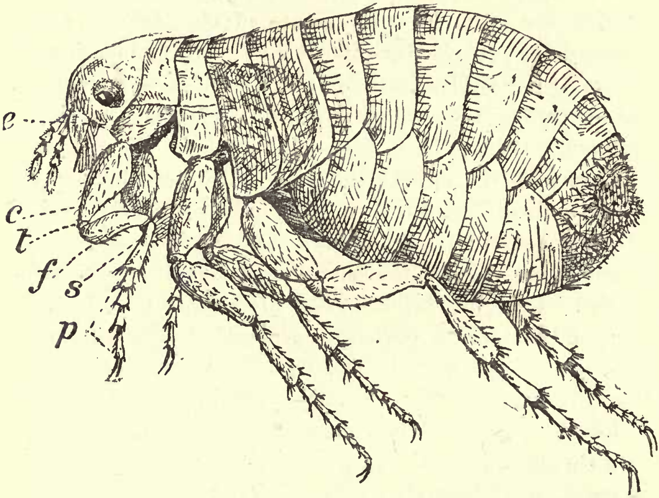


FIG. 77.—Common Flea (*Pulex irritans*), female; *e*, epimeron; *c*, coxa; *t*, trochanter; *f*, femur; *s*, tibia; *p*, tarsus.

brown chitinous skin, showing plainly enough the division into rings or segments which characterises insects and other annulose animals. The head, which is rounded above, is small in proportion to the size of the insect, and is followed by three small and separate segments, which represent the thorax; these are again succeeded by several much larger segments forming the abdomen, which, in the female, is at least three times as deep as

the head. To the thoracic segment are attached, as usual, the three pairs of legs, which increase in length from before backwards.

The legs are remarkable in several ways. At first sight they seem to have an extraordinary number of joints, and yet the parts are exactly the same as in insects generally, and follow the plan typified in the cockroach. It will be remembered that that joint of an insect's leg by which the limb is attached to the thorax is called the coxa. Now the coxæ of a flea are not only enormously large, being indeed the broadest and almost the longest section of the leg, but they are also far more completely freed from the thorax than is usually the case, being only attached by one extremity : this causes the leg to appear to have an extra joint. But this is not all. In the first pair, especially, we seem to have yet another additional joint, and this appearance is due to the fact that the *epimera* (viz., those elements of the thoracic segment to which the coxæ are directly attached) themselves project from the body of the segment, and point obliquely forwards. These arrangements give an extremely awkward appearance to the legs, but no doubt facilitate the leaping process. The trochanter is small, and both femur and tibia are about the same length as the coxa; but the tarsus, which, like that of the cockroach, consists of five joints, is remarkably long, and is terminated by a pair of long curved claws, which the insect must find extremely useful as it works its way about amongst the garments of its host, or between the bed-clothes. Most leaping insects have the hind femora very largely developed, since in them are placed the muscles which originate the impulse of projection. This arrangement is especially noticeable in grasshoppers, and in the tiny beetles called turnip-fleas, which do so much

harm to cruciferous plants. The hind legs of the flea, however, scarcely differ from the other pairs, except in length, and the proportionate dimensions of all three pairs are much the same, all having coxæ larger than would be requisite for a walking insect. All parts of the legs are beset with bristly hairs, those towards the end of the tarsus being especially closely packed. The abdominal segments also are furnished with bands of long stiff hairs across the back. No doubt these hairs—all pointing, as they do, away from the head—aid the flea quite as much as its compressed form in its endeavours to insinuate itself into the small spaces between our garments it has often to travel along in order to reach its pastures; and help, at the same time, to explain the difficulty that one experiences in attempting to hold the insect between finger and thumb.

Turning now to the mouth organs (Fig. 78), we find a far more complicated apparatus than might have been expected. The type of mouth is that called suctorial, *i.e.*, it is adapted, as we are painfully aware, for the swallowing of liquid food, obtained by a process of perforation. In this respect fleas agree with flies, and, for the matter of that, with bugs; but are totally unlike bees, wasps, and ants, to which group of insects some people have thought they show some affinity. The labrum, or upper lip, seems to be represented only by a slender saw-edged bristle, which is perforated throughout

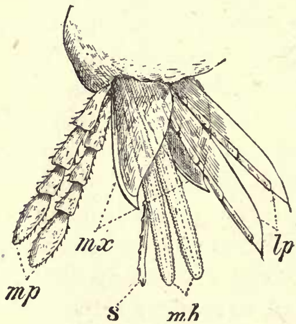


FIG. 78.—Mouth Organs of Flea. *s*, labrum; *mb*, mandibles; *mx*, maxillæ; *mp*, maxillary palpi; *lp*, labial palpi.

its length by an exceedingly minute canal. This is situated in the centre, and on each side of it are the mandibles in the form of two straight flat blades, pointing downwards, and notched on each side like a double saw. The mandibular teeth number about 75 in each row on each side, which, at the rate of two double rows to each mandible, gives a total of some 600 glistening, tooth-like projections on these weapons alone. The maxillæ are two sharp-pointed triangular pieces, which, when seen in profile, as in a specimen mounted for the microscope, have the appearance of a sharp beak; they are furnished with a pair of long four-jointed palpi, which project in front of the head, and might easily be mistaken for antennæ. The labium is reduced to a small membranous plate, which carries a pair of palpi, not quite so large as those of the maxillæ; each of these is formed into a keen blade on one edge, and rather obscurely jointed into four on the other. It is not easy to say exactly how these organs are used, since whenever we are consciously subjected to their operation, we are more anxious to get rid of the operator than to examine minutely into its method of proceeding. The whole evidently constitutes a piercing apparatus of exquisite delicacy, and the mandibles are no doubt the most effective part. We are accustomed to speak of *flea-bites*, but this is scarcely a correct way of designating the operation: the appendages of the mouth are not in any sense biting organs; the action is that of vertical piercing, not lateral pinching or nipping. In possessing palpi, fleas agree with flies, and differ entirely from the other chief order of insects with a piercing, suctorial mouth, viz., the bugs, which are never provided with such organs. On the other hand, in possessing both labial and maxillary palpi, they differ from

the ordinary flies, which are furnished with the latter only.

In the structure and arrangement of their organs of sense, again, fleas justify our statement that they are zoological oddities. While the eyes of flies are compound, each mass often containing thousands of facets, those of fleas are simple, and consist only of one rounded knob on each side; and as most of the insect's predatory operations are carried on in either partial or total darkness, it would seem that even these numerically reduced visual organs are of no great avail in the obtaining of food. The eyes are placed in the front of a hollow space, in the hinder part of which the antennæ are lodged; these are short, curiously shaped organs, and are so obscurely situated that they would certainly escape notice unless carefully looked for (Fig. 79). The hollow in which they lie is partially covered by an extension of the chitinous integument of the head, and the part still left open is further protected at a lower level by a membranous flap, which can be pushed aside when the antennæ are protruded. Their extraordinary shape, as well as their concealed and guarded position, indicates that many interesting problems await solution as to their functions and the particular uses of the several parts.

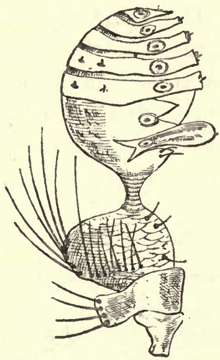


FIG. 79.—Antenna of Dog's Flea (*Pulex canis*). After Landois.

The last two thoracic segments carry a rounded scale on each side, projecting from their hinder edge. The first is a minute one, but the second very much larger,

overlapping parts of the first two abdominal segments. They are, apparently, rudimentary wings.

Fleas sometimes exist gregariously on their hosts, and those of the lower animals especially have the habit of attaching themselves most pertinaciously to some part of the body, from which no effort of their host can dislodge them. Some years ago, Mr. Verrall exhibited before the Entomological Society a colony of living fleas which had been taken shortly before from the inside of a rabbit's ear, where they were congregated on a spot from which the animal could not remove them by scratching. The neck of a fowl, again, is another place on which large numbers of a certain species have been found, collected in a small area, with their lancets buried deep in the flesh. They are not slow to discover when their host can furnish them with no further nourishment, and it is curious to notice how soon they abandon a dead body. This may easily be observed in the case of the cat's flea: if a recently defunct cat be watched, as the body becomes cold and stiff, the fleas will soon be seen struggling out from amongst the fur, though not a single specimen may ever have been seen as long as the animal was alive and warm, and its blood therefore readily obtainable.

The human flea is pugnacious, and one observer, who had confined a couple of females in a glass tube, in order to induce them to deposit eggs, describes them as immediately becoming "rampant, confronting one another like microscopic kangaroos."

Fleas are peculiar amongst parasites as being parasitic only during one stage in their career. It is only the fully grown insects by which we are troubled, and though we find them of different sizes, little ones and big ones, it must not be supposed that the former are

merely younger forms of the latter. A flea has not, throughout its life, the form with which we are familiar, nor does it in that form grow at all. The little fleas are simply the males, which are considerably smaller than the females, in accordance with a rule very frequently illustrated amongst insects. The males also differ in shape, and have the hinder end of the body somewhat turned upwards (Plate V.). In its life history a flea differs totally from a bug: the former is an insect with a complete metamorphosis, and therefore altogether differently shaped in its larval condition, while the latter is almost identical in shape during the whole of its life, and exhibits similar habits throughout; hence the tiny bugs are really young ones, though this is not the case with fleas.

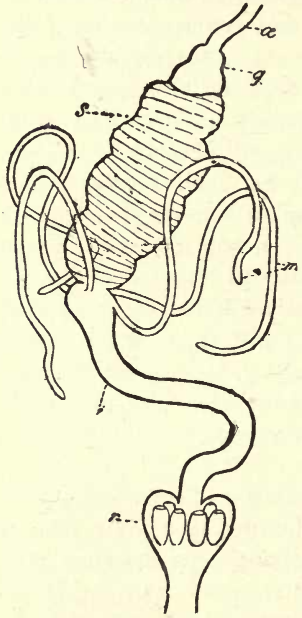


FIG. 80.—Digestive Apparatus of Dog's Flea. *œ*, œsophagus; *g*, gizzard; *s*, stomach; *m*, Malpighian tubules; *i*, intestine; *r*, rectum. (After Landois.)

The digestive apparatus of a flea (Fig. 80) consists of parts very similar in their arrangement and function to those of the cockroach, and therefore needs no detailed description. The œsophagus is a rather short and narrow tube, leading into a thick-walled gizzard, which, again, opens by its broader end into a capacious bag, the

stomach, big enough to hold a large draught of blood, such as the insect is only too eager to suck in whenever it can get the opportunity. At the junction of the stomach with the intestine are four long, thin, blind tubes, the Malpighian tubules. The hinder end of the intestine expands into an inverted, pear-shaped cavity, the rectum, on the walls of which are six oval glands.

The alimentary canal, when gorged with blood, can be rapidly emptied by the insect, and its contents ejected with considerable force, when a new and good supply of food presents itself before the last meal is disposed of. The dark stains on linen, that indicate where fleas have been, consist of their dried excrement, and are composed of the undigested remains of the blood corpuscles contained in the food. Judging from the fact that rooms that have long been unoccupied are sometimes found to be swarming with fleas, it would seem that the perfect insects can subsist for a time without their customary food, although they are rapacious and insatiable enough when it is obtainable. And even under ordinary circumstances, their living must not unfrequently be precarious, and their meals most irregular. As is well known, it is not every human being that they regard as fit to supply them with nutriment; some individuals they seem instinctively to avoid, whether by reason of a greater thickness and toughness of skin, or of something distasteful in the blood, or from some other cause, it is impossible to say. That they should prefer a host with a soft and delicate skin is only natural, and is evidenced by their marked partiality for females and young children, though it must not be forgotten that some of this apparent partiality may be due to the extra facilities that are afforded to the parasites, in the case of these sections of the community, by the character of the

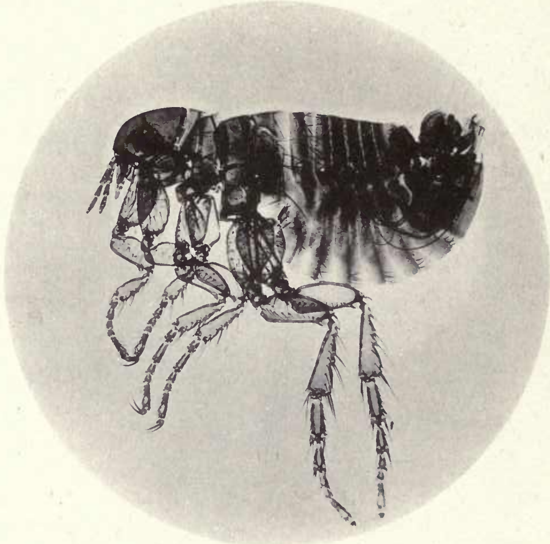
clothing, the greater looseness of which renders them easier subjects for the fleas to gain access to, and therefore to operate upon.

In consequence of the compression of the body and the comparative transparency of the skin, many details of internal anatomy may be made out in the living flea, if it be examined under the microscope with good illumination by transmitted light. The tracheæ, or breathing tubes, can thus be very easily traced, even down to many of their finer branches; and the large trunks that traverse the length of the body are especially conspicuous objects; large branches may also be easily seen running down the legs. If the flea is confined so that it can only move slightly, the contraction of the muscles, especially in the coxæ, can be watched without any difficulty, as any little twitchings occur in the legs. A living flea is a very pretty object when viewed with polarised light.

The original photographs of which Plate V. is a reproduction were obtained from specimens prepared for the microscope, and therefore completely flattened. In the process of mounting, the thoracic segments unavoidably become slightly dislocated from their natural position: this is especially noticeable in the male. The greater part of the contents of the body also have been dissolved out, in order to increase the transparency of the object, and hence very little of the internal anatomy can, in these specimens, be seen. The most prominent object in this connection is the reproductive apparatus of the male: the bars and coiled threads at the hinder extremity are all parts of these organs, and are really internal in position, though they hardly seem so. The coiled threads are attached to the part of the organ that can be protruded.

PLATE V.

FEMALE FLEA.



MALE FLEA.

Magnified about 20 diameters.

We have now to trace the life history of the flea. The eggs are oval, whitish, sticky things, and though, of course, actually minute, are yet rather large in proportion to the size of the insect itself, their longest diameter being about $\frac{1}{40}$th of an inch, and the shortest $\frac{1}{60}$th. So far as the human species is concerned, the eggs appear to be laid, not upon the body or clothes of the host, but amongst rugs, mats, and other accumulators of dust and dirt. It is commonly believed that cats and dogs bring fleas into a house, and there is certainly good evidence that at least their own parasites may be introduced in this way. For example, Mr. S. J. M'Intire states that, wishing to obtain some eggs of the cat's flea, he placed, late one night, a cloth for his cat to lie upon, and early in the morning inspected it in order to collect any eggs that might have been deposited. On the first night 62 eggs were obtained, on the second 78, on the third 67, and on the fourth 77, a total of 284 eggs from one cat in the course of four nights! No doubt many of these, if left to themselves, would never have reached maturity; still, the number is sufficiently startling, and, unless the animal in question was literally swarming with vermin, seems to indicate on the part of the cat's flea a fecundity considerably in excess of what is usually attributed to the human species, which is said to produce only about a dozen at a laying. Of course it by no means follows that the fleas which would have resulted from these eggs would have been troublesome to the human inhabitants of the house; in fact, considering the great zoological difference between man and the cat, the presumption would be in the other direction. It has, however, been asserted that the cat's flea will attack a human host; but, however that may be, it is evident that, to be on the safe side, rooms in which cats

and dogs are accustomed to lie should be frequently swept, and that the sweepings should be burnt.

From the eggs are hatched, not brown leaping fleas, but whitish, footless, worm-like maggots, whose bodies

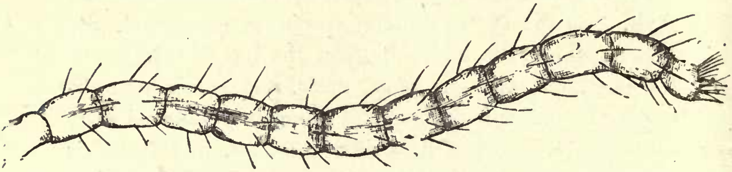


FIG. 81.—Larva of Cat's Flea (*Pulex felis*). After Kü nc

are set with long hairs (Fig. 81). Each larva consists of a head and twelve segments, the last terminated by a pair of hooks. The head carries four tubercles, a pair of short antennæ, and a good pair of biting jaws (Fig. 82), for at this period of its life the young flea devours solid food; it is neither parasitic nor a blood-sucker. These little grubs are extremely lively creatures, wriggling about vigorously, and working themselves along by aid of their hairs and caudal hooks. They appear to feed upon dry animal substances of various kinds, some fragments of which they are pretty sure to find in the neighbourhood of their birthplace. At the end of the seventeenth century Leeuwenhoek, to whom we owe some of the earliest recorded observations on fleas, kept a colony of larvæ, and fed them on the bodies of dead flies. About fifty years later, Rösel tried some larvæ with various substances, and found that they refused sawdust, both from old and fresh wood; and that so far from enjoying

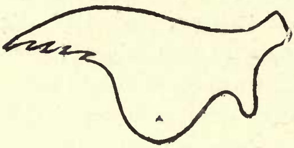


FIG. 82.—Biting Jaw of Flea's Maggot.

fresh blood, they became drowned in it when small quantities that had been extracted from a pigeon were offered them. He found, on the other hand, that they fed readily on the bodies of gnats, and on dried and pulverised blood, and these observations have since been confirmed by other observers. Bearing these facts in mind, then, it is evident that, quite apart from the parasites of our domestic quadrupeds themselves, rugs, mats, or carpets, on which such animals lie, are likely, by the accumulation there of hairs, fragments of skin, &c., to constitute an environment eminently adapted to the propagation of human fleas, the larvæ of which would find there excellent pasturage. In this connection may be quoted an experience of Professor Westwood, who discovered some larvæ in a very unexpected way. He says that, having dropped a very minute insect on the floor of his library, close to the spot where one of his spaniels was in the habit of lying, he was obliged, in order to find it, to sweep the carpet very carefully with a fine brush upon a piece of white paper. By so doing he found the insect he was in search of, and at the same time swept up what he was certainly not looking for, some small, hairy, wriggling maggots, which he at once recognised as flea larvæ. From what he subsequently states, the Professor seems to imply that these were the larvæ, not of the canine species, but of the human flea. The frequent use of the broom, therefore, wherever cats and dogs habitually take up their quarters, is eminently desirable; and not the dustbin, but the fire, should be the final destination of all rubbish so swept up. It is obvious, also, that the frequent sweeping out and cleansing of kennels, especially at the edges and in the corners of the floor, would be helpful as a preventive measure towards ridding dogs of fleas.

In the form of its larva, the flea is in complete agreement with the order Diptera, the footless, jaw-bearing maggot being, as we have seen, the usual type amongst flies.

The young flea does not enjoy a long larval life; in summer it becomes full-grown in about twelve days, and then spins a little cocoon wherein to become a pupa. This habit is apparently sometimes departed from, for Rösel records that some of his larvæ pupated without a cocoon. The cocoon is, of course, extremely minute, and to the silken threads of which it is composed are usually attached particles of dust or cotton or woollen fibre, whereby its identity is almost completely obscured. Inside the snug little abode, the tiny maggot divests itself of its larval skin, and appears as an odd, humpbacked chrysalis (Fig. 83). In this the maggot shape has altogether disappeared, and the outline of the perfect form becomes evident. Legs for the first time appear, but they are quite useless, as, in common with the rest of the insect, they are encased in a thin investing pellicle, each leg being enclosed in a case of its own. In the character of its pupa the flea resembles the Hymenoptera (ants, bees, wasps, &c.), and differs markedly from the generality of the Diptera.

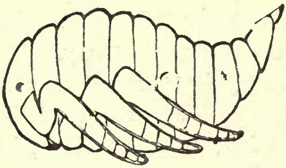


FIG. 83.—Pupa of Flea. (After Westwood.)

The developing flea remains in the condition of a pupa about a fortnight, of course taking no food during this time; it is at first dirty white, but soon darkens and assumes the well-known yellowish brown tint of the adult. From this pupa issues the perfect flea, and then, for the first time in its life, the spirit of bloodthirstiness

comes upon it; never hitherto have its mouth-organs been adapted for taking liquid food, but now it is furnished with the extraordinary collection of lancets referred to on p. 253, and would find it equally difficult to partake of solid aliment. Those larvæ which hatch from eggs laid towards the beginning of winter do not pass through their metamorphoses so quickly, but spend the winter in the larval state, remaining in a torpid condition till the warmer weather comes round and wakes them into renewed activity, and enables them to complete their cycle of changes. The flea, then, is an insect with a complete metamorphosis, therein differing *in toto* from both the bed-bug and the cockroach, and agreeing with Dipterous flies in general.

Fleas do not seem to be confined to human habitations; there is a common belief that sandy sea-shores are infested by them, and that visitors to such spots may expect to return home "with company." In support of this notion may be adduced a statement made by Mr. T. J. Bold before the Tyneside Naturalists' Club about twenty-eight years ago, to the effect that he saw fleas "dancing about quite merrily between Hartley and Whitley, and at other times they have been noticed quite frequently from South Shields to Marsden." There are, no doubt, many fragments of animal remains scattered about amongst loose sand, such as would serve very well for the larvæ to prey upon; but what the perfect insects can find to live upon in such situations is a mystery, for it can hardly be maintained that they frequent the spot with a view to possible human visitors.

That fleas can be excluded from houses by the use of odoriferous plants has long been a firmly believed tradition, witness the name of our common wayside plant, the fleabane. The smoke of this when burnt was

held to be particularly distasteful to fleas, which would forthwith abandon any premises in which they detected it. Several species of Compositæ have been credited with this potency. A preparation made from the leaves of a *Pyrethrum* from the Caucasus was at one time extensively used in Russia for driving away fleas. Wormwood (*Artemisia*) also was believed to possess similar powers, and Tusser has the following lines in illustration:—

> "While wormwood hath seed, get a handfull or twaine,
> To save against March, to make flea to refraine;
> Where chambere is sweeped and wormwood is strown,
> No flea for his life dare abide to be known."

The "sweeped chambere" had no doubt quite as much to do with the matter as the wormwood. In folk-lore the 1st of March is intimately associated with fleas. It is still a practice in Kent to keep the doors shut on that day for the same purpose, and thus it is believed that immunity from their attacks will be secured for a twelvemonth.

The muscular strength of the flea, like that of insects in general, is, *in proportion to its size,* exceedingly great. In instituting numerical comparisons, however, between it and the higher animals, by way of illustrating this fact, there are many points, not altogether obvious at first sight, which need to be considered before we can be satisfied that we have got results that are reliable, and not merely exaggerated and sensational statements devoid of any scientific value. For example, a flea is said to be able to leap to the height of a foot, which, taking the insect as a large female, is about a hundred times its own length; and it is commonly assumed that this is a stupendous feat, corresponding in magnitude to what we should get if, for the sake of comparison, we were to

imagine larger animals, such as the vertebrates, similarly constituted and endowed with powers enabling them in all cases to perform gigantic leaps to similar proportionate heights; on such a showing, this flea's leap certainly would be a marvel of muscular effort, for it would be as if an ordinary-sized man, supposed to be constituted like a flea, were able to take a vertical bound into the air which would carry him to a greater height than that of the top of St. Paul's.

A popular writer, taking a more moderate estimate of a flea's capabilities, says, "Perhaps we have not reflected that the average jump of a flea is about thirty times its own height, and that, supposing a man of six feet in stature were to perform the same leap, he would jump as high as the gallery of the Monument." Now, such an assumption is altogether erroneous, and a leap of that height would not by any means represent a similar muscular efficiency, but, on the other hand, a far greater one—in other words, it would not be "the same leap," but one immensely in excess. The problem is, in fact, not quite so simple as it seems at first sight. Suppose we consider the work done. The flea raises its own mass against its own weight through the height of a foot (taking our former estimate of the maximum leap). If a man leapt up, say, only through *the same height*, he also would raise his mass against his weight through the height of a foot, and therefore the work done in the two instances would be proportional to the weights of the two animals. Next arises the question of the energy available for doing this work; this, on the supposition of the two animals being similarly constituted, and having muscles of a similar character, will be proportional to the volumes of the muscles, and therefore to their weights, which, again, in animals similarly

constituted, would be as the weights of the animals themselves. The work done, therefore, being in the proportion of the weights, and the energy available for doing it being also in the same proportion, it follows that a leap through *equal* distances would represent equal muscular efficiency. And hence, on the above suppositions, a man's leap of a single foot, instead of something like 500 feet, would be more strictly comparable with a flea's leap of one foot. The height of the leap, therefore, does not by itself indicate any great superiority in relative muscular strength on the part of the flea.

But the question may be looked at in another light. Plateau has recently carried out some investigations as to the muscular strength of different insects by determining the maximum weight that they can lift; and though the flea itself does not happen to have been one of the insects experimented upon, yet the results obtained will tend to throw great light upon our subject. The *modus operandi* was as follows: A narrow groove was lined with cloth in order to give foothold, and the insect to be tested was placed in the groove. One end of a delicate thread was then attached to its body, and the other passed over a small pulley at the end of the groove. To the free end of the thread was attached a small pan, and sand was put into this till the insect could no longer raise it. The weight of the maximum load having been determined, as well as that of the insect itself, the ratio of the weight lifted to the weight of the insect's body could at once be calculated. By experimenting in this way with several well-known insects, Plateau established some very curious results, which at first sight seem rather paradoxical. He found that the smaller the insect, the stronger relatively it becomes, and that in every instance the strength is

proportionately far greater than that of vertebrate animals. Thus a hive-bee, weighing .09 gramme, was found to be able to lift a weight equal to 23.5 times that of its own body; while a large humble bee, weighing more than four times as much, had a relative muscular force only a little more than half as great, or, more exactly, could lift only 14.9 times the weight of its body. Similarly, a large cockchafer, weighing .94 gramme, could not raise more than 14.3 times its own weight; while a much smaller, but allied species, weighing only .153 gramme, *i.e.*, about one-sixth part as much, was strong enough to raise 24.3 times its own weight, or more than half as much again as its lumbering relative.

If now we compare these results with those derived from the higher animals, we find that, while insects can raise from about 14 to 23.5 times their own weight, the muscular force of a man or a horse, when expressed in the same way, are represented by the ridiculously small numbers .86 and .53 respectively. This high relative muscular force of insects, however, is not due to any superiority in the quality of their muscles, but is simply a direct consequence of their small size. For, with muscles similarly constituted, the contractile force depends, of course, on the number of muscular fibres, *i.e.*, it varies as the cross section of the muscles, and is therefore proportional to the squares of linear dimensions; the weight, on the other hand, depends on the volume, and is therefore proportional to the cubes of linear dimensions. Hence the ratio of the contractile force to the weight decreases rapidly as the animal increases in size, or, in other words, the smaller the animal, the stronger, relatively, it must become, by virtue of that very decrease in size. While, therefore, it is quite true that, considering their size, insects are very much stronger

than human beings, horses, or other large animals, such advantage does not necessarily proceed from any superiority in the quality of their muscles, but simply from their being so much smaller. And further than this, if their muscles were really as good as those of vertebrates, they ought, in accordance with the above calculation, to be far stronger than they are. Their "absolute muscular force," indeed, as Plateau terms it, is low in comparison with that of higher animals, although their "relative muscular force" is extremely high. So, then, if we were to magnify the dimensions of our flea, without altering the character and quality of its muscular fibres, we should gradually lessen its relative strength, and, by the time it had reached human proportions, it would have turned out to be a far inferior animal. This somewhat complex subject may be found more fully discussed in Miall and Denny's excellent work on the "Cockroach," from which the above illustrations are in substance derived, and to which those who wish to pursue the subject further are referred.

In this connection, a passing reference may be made to the so-called educated or performing fleas, which have sometimes been exhibited in different places. The chief difficulty met with in the training of fleas is, it seems, to restrain them from jumping, and to induce them to walk in an even and regular manner. One of the methods of overcoming this tendency to sprightliness is to imprison them in circular glass-topped boxes which are kept revolving: every leap they take brings retribution in the shape of violent collision with the sides of their cell; and, as they are at the same time dazed, it is believed, by the movement of the box, they seem to get tired of this unpleasant experience, and, after a while, cease leaping, and settle down to a steady walk. Mr. W. H. Dall,

an American entomologist, who once visited an exhibition of performing fleas with the view of determining to what extent the performances were really the result of training, and how far, therefore, they indicated any docility in the performers, came to the conclusion that all the movements consisted of struggles on the part of the insects to escape, and that what looked like concerted action, in which, of course, the greatest amount of intelligence seemed to be exhibited, could be accounted for in other and more natural ways. Take, for example, the waltzing, in which the fleas go spinning round in pairs to the sound of a musical box. Two fleas of equal size and strength are attached to an extremely delicate piece of wire, one at each end; but as they are fastened in such a way as to face in opposite directions and at right angles to the wire, their struggles produce equal and opposite pulls at the end of the bar, or, in other words, form what in the language of mechanics would be termed a "couple," and therefore necessarily produce, without any intention on their part, a rotary motion. To aid in the illusion, a small orchestra is added, consisting of fleas fastened before tiny models of musical instruments. As they are set upright, their legs can only flourish about in the air, suggesting the idea of their performing on the instruments; and if they should be at all slow to begin their "pawings," an attendant stirs them up by running a little barb from a feather across their legs, when, of course, they set to work kicking about vigorously. In the duelling performance we have something very similar to the orchestra: two fleas are fastened upright to little wire pillars, and tiny wands in lieu of swords attached to their fore-legs; they are placed opposite one another, but at such a distance that they are just out of one another's reach, except with the

"swords." As they brandish their legs about in their efforts to liberate themselves from their constrained position, it will occasionally happen that their "swords" will meet and produce the semblance of the clashing of weapons in a combat. Frank Buckland, in the account he gives of performing fleas, speaks of the supply as coming chiefly from elderly females (!), and of the price as ranging from 3d. a dozen in summer to 6d. in winter. He also states that the best fleas for this purpose are obtained from Russia, whence they are sent in pill-boxes, packed in cotton wool.

The common flea is cosmopolitan in distribution; not so, however, that far more formidable but allied pest, the chigoe or jigger (*Sarcopsylla penetrans*) of tropical America. This villainous insect (Fig. 84), a short notice of which may appropriately close this chapter, is something like a small flea, and is particularly noteworthy for two peculiarities, viz., the enormous size to which the abdomen of the female swells, by reason of the development of the eggs, and the marvellous habit it has of burrowing beneath the skin of its victims, thereby producing intense pain, ulcerations, and even sometimes death. It is only the female that thus burrows. After impregnation, she seeks the foot of a suitable host, and by means of her powerful mandibular lancets, perforates the skin obliquely, usually beneath the toe-nail, and works herself under the surface till the tip of the abdomen only is visible. While she is in this position, the eggs, which are said to be as many as a hundred in number, advance towards maturity, and the body of the insect now swells to a large globular form, the head and thorax, of course, still retaining their original diminutive proportions; the increase in size continues till the eggs are ready for laying, when the abdomen is about the size

of a small pea. After so enormous a dislocation of the abdominal viscera, it is perhaps not surprising that the deposition of the eggs should be the supreme effort of

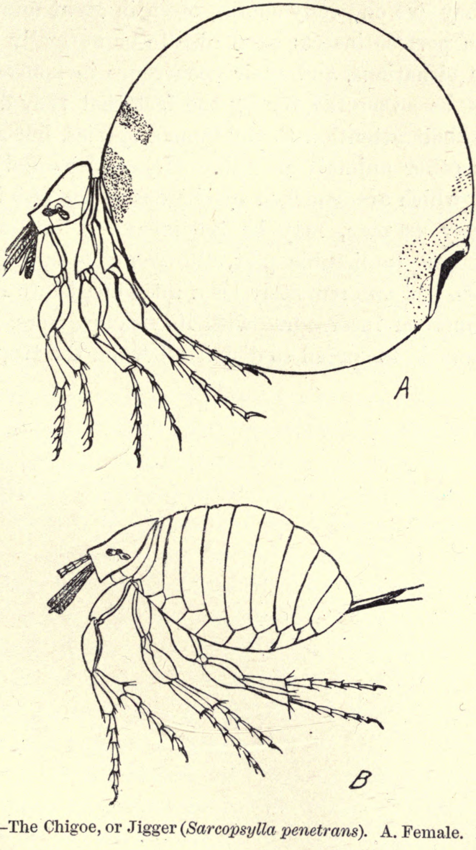


FIG. 84.—The Chigoe, or Jigger (*Sarcopsylla penetrans*). A. Female. B. Male.

the insect. From the time of fecundation to that of oviposition it lives solely to develop its progeny, and when the eggs are laid it perishes, leaving in the wound

which has formed its resting-place only a shrivelled skin, which soon falls away.

The larvæ are of similar habits to those of our own flea; they live on sandy shores, often in great numbers; and the perfect insects seem also to be normally found in such situations, and their occurrence in houses may perhaps be accounted for by the fact that they do not confine their attention to the human species, but attack various other animals as well. Hence, dogs and mice, both of which are attacked by chigoes in the feet in the same way as man, may be the means of introducing them. This intolerable pest, the worst of all human parasites, has unfortunately been introduced into Africa by commercial intercourse with its headquarters, but it seems unable to spread to districts beyond the tropics.

CHAPTER XV.

THE BED-BUG.

It has already been pointed out that the migrations of some insects are largely dependent upon the commercial enterprise of nations, and that it is to our own widely extended commerce that we can trace the introduction into this island of our kitchen pest, the common cockroach. We have now to consider another and much less desirable importation, which we owe to a similar source. The bed-bug, though now, unfortunately, firmly enough established, is not indigenous here, and appears to have been known as British for about the same length of time as the cockroach, although it is, of course, impossible to assign a definite date for its introduction. Like the cockroach, it appeared first in seaport towns, whence it spread to other parts; but its advance to inland regions was slow, if we may judge from a *brochure* entitled "A Book of Buggs," written by John Southall in the year 1730, in which he points out that at that date, *i.e.*, nearly 250 years after we first hear of the insect, though "not one seaport in England is free from them, in inland towns buggs are hardly known." The earliest record of its occurrence in Britain is to be found in a Latin treatise on "Insects, or Minute Animals," by Thomas Mouffet, published in 1634. This writer, who does not state whence he obtained his information, says that in the year 1503, two ladies of noble family,

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residing at Mortlake, became greatly alarmed at finding themselves one morning bug-bitten, not knowing the cause of the inflamed swellings which had appeared upon their persons, and thinking they had contracted some frightful contagious disease. That even at this early date the insects were not entirely unknown, though certainly strange, appears from the ease with which the disquietude of the noble sufferers was allayed by their physician, who was at once able to point out to them the real cause of their disfigurement.

The inelegant monosyllable we are now accustomed to use as the name of this horrid parasite does not seem to have been applied to it at first; even Mouffet, who speaks of it in Latin as *Cimex*, gives as the English equivalent of this "wall-louse," but does not mention the word "bug" at all. This, however, is only negative evidence; and as there appears to be an undoubted reference to the insect under the shorter name in a play of Massinger's, dated twelve years earlier than Mouffet's treatise, it must have been at least in occasional use at that period. "Chinch" is another old name for it, which appears to have become extinct only a generation or two ago.

The origin of the modern name is somewhat obscure. As applied to the insect, the word "bug" has usually been supposed to be identical with the old British word of the same form, meaning a hobgoblin, or nocturnal apparition, a word still existing in the compound "bugbear"; and the idea was that the name was transferred to the insect in consequence of its nocturnal and disgusting habits, and the alarm they occasioned when, as in the instance above referred to, the cause was unknown. But Dr. Murray points out in the "New English Dictionary" that this is mere conjecture, and no

direct evidence of the transference of the name is forthcoming; hence it is safer to regard the etymology of the word, as applied to this and other insects, such as the May-bug, &c., as at present unknown. In Shakespeare the word occurs several times, in the sense of a spectre, but never as the name of the parasite, which, indeed, does not appear to be mentioned by that observant author, a tolerably good indication that it was not very common in his time. Southall, indeed, maintains that when he wrote, bugs had been established in England only for about sixty years, which would throw their first appearance down to the year 1670; but this idea is plainly refuted by the notes of time already mentioned.

To entomologists the bed-bug is known as *Cimex lectularius*. *Cimex* was the name by which it was known to the Romans, and hence was selected by Linné as the generic term for bugs in general. The specific name *lectularius* is derived from the Latin word for a couch or bed, and of course refers to the locality in which we most frequently meet with it.

Though annoying us in the same way as the flea, the bed-bug is yet a totally different sort of insect, and in its life-history departs as widely as possible from its companion bedroom pest. The flea, it will be remembered, we regarded as a sort of wingless fly, and therefore located it in the order Diptera. The bug, on the other hand, belongs to the order Hemiptera, and finds some of its nearest allies in the plant-bugs, water scorpions, water boatmen, skaters, &c. The most fundamental distinction between these two orders lies in the nature of the metamorphosis. The Diptera, or flies, as we have already shown, pass through the usual changes in the course of their development, appearing

first as a grub or maggot, next as a limbless motionless chrysalis, and then as the perfect fly; but the Hemiptera or bugs pass through no such remarkable alterations of form, and in their early life show a general resemblance to what they will ultimately become, differing from the adult chiefly in size and depth of coloration, and in the absence of wings and the immature condition of the reproductive organs. Thus, while the young flea, when hatched from the egg, is a wriggling, worm-like creature, without limbs, and utterly unlike its parents, the young and newly hatched bug is a six-legged running creature, to all intents and purposes a miniature reproduction of its parents, and a forecast of what it will itself in a few weeks become. Hence fleas and bugs, though alike in blood-sucking habits, and human parasitism, are yet at almost opposite poles in the series of developmental types.

In the form of the body, again, there is the strongest possible contrast between these two parasites. Both are extremely narrow in one direction, and broad in another; but in the flea, the body is extended vertically and contracted laterally, and in the bug it is extended laterally and contracted vertically; the former is *com*pressed, the latter *de*pressed. Fig. 85, representing diagrammatically a vertical transverse section of the two insects, strikingly shows this difference. The extremely depressed and flattened form which the bed-bug exhibits is by no means exceptional in the order Hemiptera; in

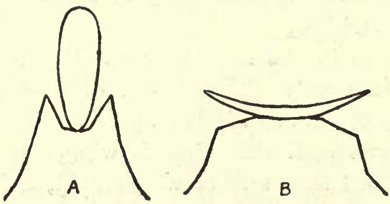


FIG. 85.—Diagrammatic Section of Body of (A) Flea, and (B) Bed-Bug.

fact, this order contains amongst its species by far the flattest of all insects; "B flat" is a sobriquet not more applicable to the bed-bug than to several other kinds that are not parasitic at all. Such flatness is always associated with the habit of hiding in cracks and crevices —a habit in which, every one knows, our bedroom pest is a perfect adept. In flatness, however, it does not equal a certain wild British species which lives under the bark of willow-trees, and has a body of almost paper-like thinness.

The disgusting odour which attends the bed-bug would alone be sufficient to excite repugnance, and to prevent its habits from being much studied. But as this smell completely goes off after death, there is nothing but the natural prejudice against a personal parasite, and one so closely associated with uncleanly conditions, to render a careful examination of the dead insect an unpleasant experience. There are many delicate touches in the portraiture, even of an insect which, when alive, is so repulsive; it is not all coarseness and vulgarity, and the compound microscope, the use of which is necessary to make out the minuter details, reveals many interesting features.

For examination, the insects may be killed by being plunged into *boiling* water, or by being exposed for a time to the fumes of chopped laurel leaves. In either case, their sickening smell soon disappears. Even at their largest, they are not more than a quarter of an inch long, and hence are too small and delicate to be touched with the fingers without great risk of damage, and a pair of fine forceps is necessary for handling them. When fully grown, they are of a deep rust-red, tinged with black here and there in the abdomen. The head and foreparts are somewhat lighter than the rest

of the insect. Of the three divisions of the body, the head is the smallest (Fig. 86); its hinder part is of an oblong

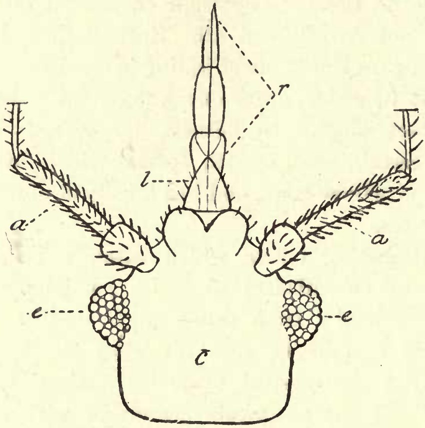


FIG. 86.—Head of Bed-Bug, with Rostrum extended. *a*, antennæ; *c*, crown; *e*, eyes; *l*, labrum; *r*, rostrum. *N.B.*—The last joint of the antennæ and part of the next have been removed.

shape, broader than long; the eyes form projecting knobs at the sides, and the base of the mouth organs a considerable prominence in front, whereby the head, as a whole, acquires roughly a pentagonal outline.

The mouth organs form a sort of beak, called the *rostrum;* and this, as is usually the case in the Hemiptera, is tucked back underneath the head (Fig. 87), running along the central line, as far as the base of the first pair of legs, the head being slightly grooved beneath for its accommodation. At its junction with the head, the rostrum is more flexible than elsewhere, so that it can be brought out from the position of rest and held either

FIG. 87.—Side view of Head of Bed-Bug, showing position of rostrum (*r*) in rest.

pointing vertically downwards, or even sloping forwards, when required to be used. By reason of the constant presence of such a beak-like apparatus as this, the name Rhynchota, *i.e.*, beaked insects, is frequently used instead of Hemiptera as the name of the order. Lapping over the front of the beak, at the spot where it joins the head, is a triangular plate, the labrum, or upper lip. The beak itself consists of a three-jointed, tubular, or rather gutter-shaped organ—the labium—the channel of which is nearly closed above (*i.e.*, on the surface which is forward-looking when it is in use) by a thin transparent membrane, which is easily bent aside. Within the channel lie, side by side, and perfectly free, four fine, straight, bristle-like organs, which, like those of the gnat or mosquito, represent the mandibles and maxillæ of other insects. The mouth is therefore of the suctorial type, and suited only for feeding on liquids; but it is adapted, not solely for sucking up exposed juices, as is that of butterflies and moths, nor for licking them up like that of bees, but for getting at liquids which are enclosed within covers or boundaries which need to be pierced before their contents can be reached. There is thus no power of biting, strictly so called; hence the term "bug-bite," like "flea-bite," is somewhat inexact.

In the presence of this boring apparatus, the whole order of bugs agrees with many of the flies, and notably, as we have seen, with gnats and mosquitoes. Notwithstanding the general agreement, however, there is one strongly marked difference between the two orders; flies always have one pair of palpi, and sometimes two, attached respectively to the maxillæ and the labium, but no such organs are ever found in bugs; hence the mouth in the Hemiptera is of a simpler construction than in

the Diptera, through the suppression of parts which are, except in this order, almost universally present, and generally very prominent. This suppression and simplification is the more remarkable because the bugs are in some respects a more primitive race of insects than the flies, and might so far have been expected to show a more generalised type of mouth. It is impossible at present to do more than speculate as to the significance of this absence, as separate organs, of parts which are in most insects amongst the most prominent of the food-taking apparatus, and which are endowed with such a power of persistence, so to speak, that in some cases they remain distinct after the organs to which they belong, and of which they are appendages, have become fused with the rest, or have disappeared altogether. Too little is yet known of the function or functions of palpi in general, to be able to imagine what can be the influence upon the economy of the insects of the defect under which they labour. One would think that by contrasting the habits of the not-palpi-possessing Hemiptera with those of the palpi-possessing Diptera, it would become possible, by detecting constant differences between the two orders, to arrive at some valid conclusion as to the function of these organs. Such, however, does not seem to be the case; and if there is any marked difference in the way of taking the food, or in other respects, it has yet to be discovered. We know no more why the blood-sucking mosquito should possess palpi than why the equally blood-sucking bug should be without them. Some maintain, however, that the channel-like beak itself consists of the fused labial palpi instead of the pair of jaws to which they belong, in which case the above remarks would lose some of their force.

Of the two pairs of bristles (Fig. 88), one (the mandibles) is considerably stouter than the other (the maxillæ), and the latter are exceedingly fine and delicately saw-like at the free end. Each mandible possesses a sort of flange, along which the corresponding maxilla slides, and thus the four bristles unite into one boring weapon. As every one knows, the wound this weapon can inflict is, at least in some cases, exceedingly painful, and productive of considerable inflammation. Not that any poison is instilled into it, so far as appears; but the very minuteness of the punctures seems to be the cause of the irritation, just as a prick with an exceedingly fine needle often causes intense pain. A few words are necessary to complete our picture of the bed-bug's head, for we have yet to speak of the antennæ and eyes. The former (Fig. 89) proceed from the upper surface of that part of the head which lies between the eyes and the base of the rostrum, and are remarkable for the small number of their joints, four only being discernible; the basal joint is small and stout, but the other three long, and, except the second, very slender—much finer, in fact, than a human hair. In the fewness and length of the joints of the antennæ, the bed-bug is quite in accord with the rest of the members of the division of Hemiptera to which it belongs, viz., the Heteroptera. One usually thinks of antennæ as composed of a great number of short joints, and such an idea would be correct for the vast majority

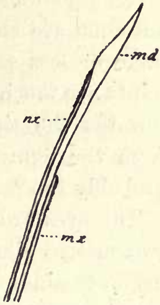


FIG. 88.—Piercing Apparatus of Bed-Bug. *md*, mandibles; *mx*, maxillæ.

FIG. 89.—Antenna of Bed-Bug.

of insects, but not for the Heteroptera, in which sub-order alone we find antennæ composed of a small number of long joints. Like all the rest of the body, the bug's antennæ are clothed with hairs, which are, no doubt, more or less sensory in function; those on the basal joints are much coarser and more thickly set than those towards the tip. The last joint, as will be observed from the figure, is slightly clubbed at the end, and is probably the most highly sensitive part.

The eyes are black and very prominent, appearing as two masses like little blackberries at the sides of the head, reminding one of the corresponding organs in certain small ant-like beetles (*Pselaphidæ*) which inhabit moss or lurk under stones. The bed-bug is somewhat exceptional amongst Hemiptera in not possessing, in addition to its compound eyes, the small simple ones called "ocelli." Two such are usually to be found, in this order, between the compound eyes, but our present insect is destitute of them.

The thorax, or, as we ought rather to say, the prothorax (Fig. 90), is curiously shaped, being much wider than long, and having broad leaf-like expansions of its chitinous covering at its sides. These run forward by the side of the head almost as far as the eyes, and so form a notch into which the head loosely fits, and whereby its sideward motion is considerably restricted, as if by a stiff collar. A similar peculiarity, viz., the winged margin to the thorax, will be familiar to microscopists as occurring in the little lattice-winged insects called "thistle-bugs" (*Monanthia cardui*), which are found abundantly on thistle-heads, and are often

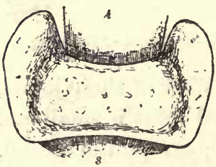


FIG. 90.—Prothorax of Bed-Bug. *h*, head; *s*, scutellum.

mounted whole as opaque objects for the microscope, under the name of *Tingis.* The other two segments which go to make up the complete thorax are not very easy to trace above, though evident enough beneath. The only part that appears prominently is a central triangular plate of the mesothorax, called the *scutellum.* On each side of this we see the fore-wings, which are in a very rudimentary condition, and, fortunately for our comfort and peace of mind, quite useless for flight.

In these little scale-like appendages can still be recognised, though in a greatly abbreviated form, one of the essential elements of the hemipterous wing; and it will be necessary here to consider the general plan of the complete wing, if we are to understand the ridiculously reduced and utterly inefficacious scraps which the bed-bug retains, perhaps as the relics of a former superabundance. In hemipterous insects generally, then, the fore-wings, or rather elytra, are so constructed that some of the principal nervures divide them very distinctly into separate areas, at the junctions of which the wing can be angularly bent downwards. The degree to which this is the case varies in different species, and we will take one of the commonest insects we possess as illustrating a very usual type, and one of considerable complexity. During the summer months there may be found in profusion on many wayside weeds, as well as on plants in gardens, a bright green insect, a little over a quarter of an inch long, which by an inspection of its mouth, or by its odour, may be easily recognised as a member of the order Hemiptera. Its name is *Calocoris bipunctatus*, and it is an active four-winged creature, which readily takes to flight; a few specimens may easily be secured in a pill-box, and thence transferred

to a killing-bottle. After death, the fore-wings may be easily detached and mounted on white cardboard, when they will be ready for examination with a lens.

Fig. 91 shows one of the elytra of this insect; the basal part is rather stiff and horny, and brightly coloured with green or orange; the tip is of much more delicate texture, being quite thin, flexible, and transparent, and devoid of bright colour. This difference of texture in the two parts of the wing, which is a very constant character, is the foundation for the name Hemiptera, *i.e.*, "*half*-wings," as well as for that of Heteroptera, *i.e.*, "*dissimilar* wings."

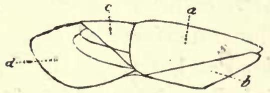


FIG. 91.—Left Elytron of *Calocoris bipunctatus*. *a*, corium; *b*, clavus; *c*, cuneus; *d*, membrane.

The horny basal part consists of two areas divided by a flexible junction: the outer one, a four-sided piece, with two long and two short sides, being called the *corium*, and the inner, a roughly triangular piece, the *clavus*. At the margin of the corium furthest from the body is a small triangular or wedge-shaped area, almost as stout as the corium itself, but distinctly divided both from it and from the more remote part; it is called the *cuneus*. The rest of the wing, constituting the whole of the tip, is quite flexible, and is spoken of as the *membrane*. When the elytra are closed (Fig. 92) the shortest sides of the two triangular clavi exactly meet on the back below the apex of the scutellum, while the inner edges abut on its sloping sides. The membranes, however, overlap

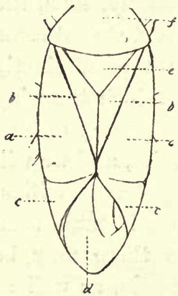


FIG. 92.—Closed Elytra of *Calocoris bipunctatus*. *a*, corium; *b*, clavus; *c*, cuneus; *d*, membrane; *e*, scutellum; *f*, prothorax. The right membrane overlaps the left.

one another, and the elytra then extend at least as far as the end of the body, not unfrequently projecting a little beyond it.

Such is one of the commonest types of fore-wing in the Hemiptera; but it is a peculiar fact that in this particular order the different areas of the wing seem possessed of varying degrees of stability, so to speak, and nothing is more common than for one or more of these parts either to be very much reduced in size or to remain altogether undeveloped, not as a mere accident in some one unfortunate individual, which may take place in any order, but as a permanent arrangement for the whole species. The membrane is the first part to be affected, and in many species it either disappears entirely or is reduced to a mere narrow border on the harder part of the wing. The cuneus is in many cases omitted altogether, and in the so-called apterous forms, of which the bed-bug is one, both the clavus and corium may be reduced to an indefinite extent. Now, in the bed-bug there is only one scale-like piece on each side without subdivisions; this is a rudimentary corium; clavus, cuneus, membrane, are all absent. The elytron, thus abbreviated, is a somewhat oval, reddish-brown object (Fig. 93), very deeply punctured, *i.e.*, covered with rounded pits, not perforations, which are technically called punctures. Similar punctures cover the whole body, except where the segments overlap, in which places the surface is smooth and polished, whereby friction is lessened; the punctures on the elytra are, however, larger than elsewhere, and each gives origin to a hair.

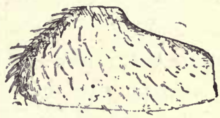


FIG. 93.—Left Elytron of Bed-bug.

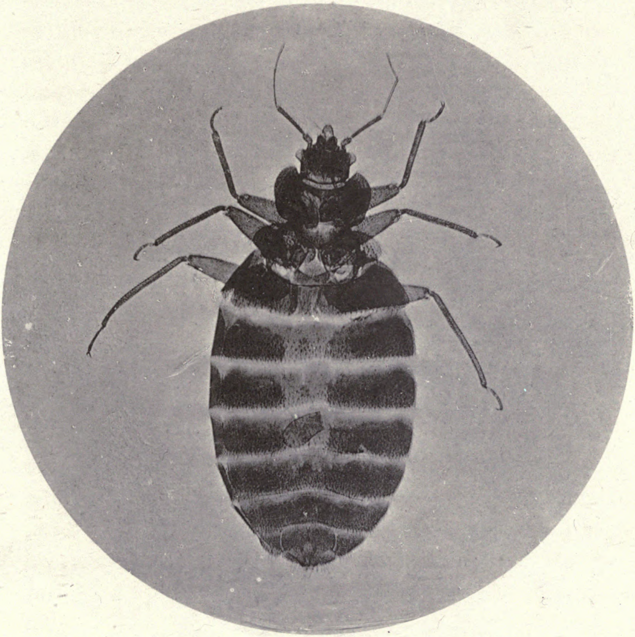
The hind-wings of the Hemiptera are as unstable as the fore-wings, and very generally, if the latter are

abbreviated, the former are entirely absent. When present, they consist of an extremely delicate membranous expansion supported on a few nervures; they may be seen in one of their most beautiful forms in such an insect as the Water Boatman (*Notonecta glauca*). The bed-bug (Plate VI.) has no hind-wings at all.

But there is a further puzzling peculiarity connected with the wings of the Hemiptera that is worthy of thoughtful consideration. Those species in which the wings are usually more or less imperfectly developed occasionally yield individual specimens in which the full degree of development is attained, all the parts being present in their proper proportions. Such cases are usually rare, sometimes extremely so, and the causes which produce the fully matured forms still await discovery. Take, for example, a very common insect, the so-called Ditch Skater or Water Cricket (*Velia currens*). Every one will remember to have seen this creature living gregariously on the surface of ponds or streams, skating about in lively fashion, like a company of spiders enjoying an aquatic picnic. Almost always this insect is entirely destitute of wings, showing not even the merest rudiments of them. And yet, very occasionally, amongst a crowd of specimens, all of the ordinary form, there may be detected an individual with fully formed elytra and wings, and therefore capable of flight. But the occurrence is a most exceptional one, and the discovery of a *fully developed Velia* always marks a red-letter day in the diary of an hemipterist. And the same thing holds good of the majority of those bugs which as a rule have undeveloped wings.

Now, as our domestic pest is one amongst the number of these unfinished forms, the question arises whether it ever assumes the fully winged condition, and if so, what

PLATE VI.



FEMALE BED-BUG.

Viewed from above, and magnified about 9 diameters.

In consequence of the flattening necessary for mounting as a transparent object, the abdomen is unduly elongated, showing, between the segments, clear, thin spaces, which should be concealed by their overlapping. Inside the abdomen, near the middle, an egg may be seen.

it looks like then, and what its power of flight may be. That such a disgusting insect should add to its resources the power of flight, whereby it might become increasingly annoying by settling on the bodies of respectable citizens as they walk the streets, and by regarding every open window, in even well-to-do neighbourhoods, as an invitation to enter, would immensely increase the loathing with which it is now regarded in respectable society; and it is a comfort to know that no record exists of winged bed-bugs having ever been met with in this country. There have been reports that such specimens have been seen somewhere in the East, but there appears to be no authentic record of any such occurrence; still, it is well to bear in mind that such a thing is a possibility, though most likely an exceedingly remote one. If wings were present, there would probably be no cuneus to the elytra.

The acquisition of wings by insects that are usually unwinged of course greatly facilitates the spread of the species, which would otherwise have to trust, for extending the area of their distribution, to their own legs, or to conveyance upon, or by means of some other animal gifted with superior powers of locomotion. As the bed-bug, however, has chosen to attach itself to the most migratory animal in the world, and gains all the advantage of man's artificial as well as natural means of locomotion, it would seem that a winged form is not a matter of such prime importance to it as to wild species that do not possess these extra advantages, and therefore the mere fact of the bed-bug's parasitism probably militates against its occurrence as a fully developed insect.

There is not much externally to distinguish the sexes; in both the abdomen is broad and flat, but that of the male is rather the smaller and narrower of the two, and

there are differences in the form of the terminal segments. In most of the field-bugs the abdomen is rather widely bordered on each side by a flat margin, distinctly marked off from the rest of the body. In the bed-bug, however, this margin, which is called the *connexivum*, is reduced to an exceedingly narrow line, and is scarcely perceptible.

Turning the bug over on its back, we now proceed to examine the under side. The chief point to be noticed here is the position and attachment of the legs. They are all let into hollows in the thorax as usual by the

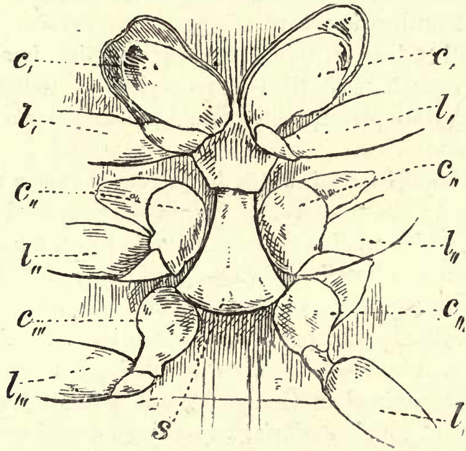


FIG. 94.—Under side of Thorax of Bed-Bug. $c_{,}$ $c_{,,}$ $c_{,,,}$ coxæ of 1st, 2nd, and 3rd pairs of legs; $l_{,}$ $l_{,,}$ $l_{,,,}$ 1st, 2nd, and 3rd pairs of legs; *s*, flap under which the scent-glands lie.

coxæ (Fig. 94). The coxæ of the first pair are almost close together, there being only room for the tip of the rostrum between them, but the other two pairs are separated by a considerable interval, and the space between them is occupied by a raised surface covering

the glands by which the volatile fluid is secreted which imparts to the insects the disagreeable odour they are noted for. The glands open by a very fine aperture situated beneath a kind of flap, which runs from the meso-thorax down between the coxæ of the hind legs.

In the possession of these odoriferous glands the bed-bug is by no means exceptional; it is one of the usual characteristics of the order, and the odour of some of the larger wild species is far more powerful, though of the same class. The liquid secreted is a colourless oily substance, and it would appear to be continually being given off during life. Its smell is of a compound nature, and a keen-scented person will detect, underlying the more disagreeable elements, the scent of a freshly cut cucumber. That the disagreeable character of the bed-bug's secretion is not due to the animal nature of its food appears from the fact that a precisely similar odour is exhaled by those species that subsist on vegetable juices. In some wild species the fluid seems to be of a different constitution, as it is quite pleasantly fragrant. *Coranus subapterus*, for example, a grey species which is found running on the ground in heathy and sandy places, exhales, when handled, a perfume which has been compared to that of jargonelle pears. But of whatever nature the scent may be, it is no doubt protective in function, and the insects are by its presence rendered nauseous and distasteful to birds and other enemies. The bed-bug does not seem, however, as it is now circumstanced, to derive much protection from its odour, for, apart from its presence being thus plainly advertised to man, the common cockroach will, notwithstanding the smell, devour it with avidity; and no doubt tragedies of this kind are of nightly occurrence in the slums of seaport towns, where both of these intruders have taken up their quarters and multiplied

till their armies have amounted to tens of thousands. Here, then, is a good word for the cockroach, although it may fairly be questioned whether the remedy is not almost as bad as the disease.

The eggs of the bed-bug are small, white, oval objects (Fig. 95); they are laid in cracks and crevices, and are caused to adhere to the surface on which they are deposited by a kind of varnish with which they are wet when laid. According to Southall, about fifty eggs are laid in each batch. The young bugs make their entry into the world by pushing off a kind of lid at the end of the egg, and the empty egg-shell then looks like a little round-bottomed china jar, with a neat rim round the opening. The newly hatched bug is a very minute, transparent, six-legged creature, showing no trace of the brown colour which characterises it in adult life. It is sufficiently transparent to reveal something of its internal economy through the skin; and after it has had a meal of blood, a dark red spot appears in the region of its digestive apparatus. It has a broad triangular head, and the antennæ are short, and proportionately much thicker than when full grown. Of course, no signs of wings are apparent while the insect is in this immature condition (Fig. 96).

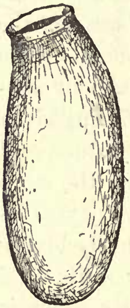


FIG. 95.—Egg of Bed-Bug.

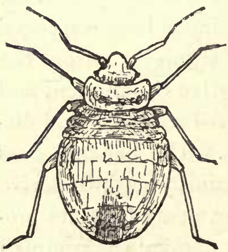


FIG. 96.—Newly hatched Bug.

During the course of the larval life the skin is shed several times, each moult being accompanied by a closer approach to the form of the

adult. The operation is effected in the same way as in the cockroach, viz., by the splitting of the skin along a straight line down the middle of the back in the region of the thorax, and the whole animal gradually extricates itself at this aperture, carefully removing not merely the more robust parts of the body from their covering, but neatly withdrawing also the more slender parts, such as the legs and antennæ, each separately from its own sheath. During the moult, the claws at the tips of the tarsi are useful in obtaining a foothold on the irregularities of the wood, paper, &c., on which the change takes place; by this means the shells of the limbs are prevented from becoming crushed and collapsed, and are enabled to retain their proper forms; hence, but for the distortion caused by the fracture along the back, and the paler tint, the cast skin (Fig. 97) might easily be mistaken for the insect itself.

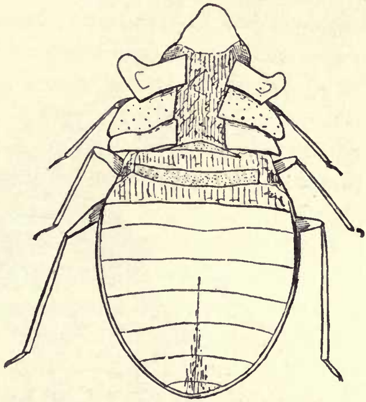


FIG. 97.—The Cast Skin of an Adult Bug, seen from above.

The last moult but one introduces the form usually called the nymph (Fig. 98), which corresponds to the chrysalis of those insects whose metamorphosis is complete. As the bug grows with each moult, its colour deepens, and its skin becomes harder and less flexible, so that when it has reached the nymph stage it closely resembles the adult, though still rather smaller. The

chief differences perceptible are in the region of the hinder part of the thorax and the fore part of the abdomen. The prothorax is very similar to that of the adult, the leaf-like margins projecting by the sides of the head; the next two segments, however, have not become so specialised as will ultimately be their fate, and they appear as distinct bands right across the body. The first of them, which is the meso-thorax, already shows, however, a slight

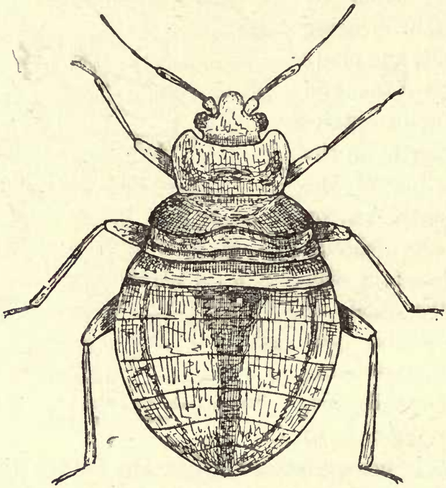


FIG. 98.—Bed-Bug at the Nymph Stage.

indication, at the sides, of the outline of the fore wings. The next three segments are very similar to one another, and no distinct line of division shows where the thorax ends and the abdomen commences. But if we remember that the thorax consists in all of only three segments, and that the first of these is the very distinctly marked prothorax, the determination of the line of junction of the chief regions of the body becomes easy.

While in the nymph condition the bug is still just as active as before, and continues to take food with equal readiness. At length the final moult occurs, and the insect is sexually mature, and acquires its rudimentary elytra, or upper wings. No further growth takes place, as, owing to the inflexibility of the skin, this can only be effected by moulting. The food now taken, therefore, serves not for increase of bulk, but to maintain the proper balance of the activities of the body, and to supply materials for the perfecting and discharge of the reproductive functions. The insect is said to require in all about eleven weeks to reach maturity, but the exact duration of its metamorphoses is no doubt greatly dependent upon the regularity and amount of the supply of food. In the adult condition it can certainly endure long fasts with impunity. De Geer kept several in a sealed bottle for more than a year without food. It is also a well-known fact that bugs sometimes absolutely swarm in houses that have for a long time been uninhabited. In such cases it is obvious that they have managed to exist without access to human blood; still it does not necessarily follow that they have been entirely without food of any kind; and when we remember that their human parasitism is probably an acquired habit, their appearance under such conditions will be less difficult to understand.

It has been supposed that they are able to abstract juices sufficient to support life from the woodwork of buildings; and if we take into consideration the absorptive properties of unpainted soft woods, such as deal, it seems far from incredible that such may be the case. That an insect which has been accustomed, during the greater part of its individual life, to subsist upon animal matter, should suddenly change its diet and feed upon

vegetable substances, or upon mere inorganic moisture, and the slight amount of organic matter that may contain in solution, would in most cases be an unprecedented proceeding; and there are hosts of insects which would rather starve than do it. But it is not at all an unusual circumstance in the order Hemiptera; and several of the wild bugs seem to be quite indifferent as to whether they are supplied with an animal or vegetable diet. Another suggestion by which it has been proposed to account for their presence in uninhabited houses is that, the colony having been established during the human occupation, they have, since the desertion of the premises by their hosts, preyed upon one another, and so sustained life. But an obvious objection to the theory is, that by such a course their numbers would be speedily thinned, and the colony would probably soon become extinct, a result which by no means tallies with experience. If in such cases the bugs really found any difficulty as to the commissariat, of course migration would be open to them; and it is difficult to believe that, enterprising as they are, they would not avail themselves of such an expedient, if really hard pressed by famine.

While it may be admitted that the hard-skinned, ungrowing adults can subsist for long periods without food, it is probable that the younger and softer skinned forms, in whose bodies the vital processes are more rapid, require more frequent supplies. Such, at any rate, is the experience of those who have attempted to rear any of the wild species of Hemiptera with which our woods, fields, and hedges swarm. As the surest and safest way of avoiding bugs in the house is the cultivation of scrupulous cleanliness, it would seem probable that the miscellaneous material included under the name "dirt," which is, much of it, of organic origin, may

contribute in some way to their support; but still it must be borne in mind that, owing to the peculiar structure of their mouth organs, whatever be the nature of the material from which they derive their food, only its liquid portions can be partaken of. Anyhow, there seems little doubt that human blood is not an absolute necessary of life to this disgusting parasite, and perhaps may be more correctly regarded as a luxury; and it is quite possible that before its association with mankind, *Cimex lectularius* may have been a purely vegetable feeder, subsisting on the sap of trees. Southall declares that he fed the numerous families he kept on such food as this, using chiefly deal for the purpose. Hard woods, such as oak, walnut, and mahogany, or scented woods such as cedar, they failed to extract any nutriment from, and died if confined with these alone.

Like all other insects, bugs, of course, breathe by inhaling air, not at the mouth, but at certain openings in other parts of the body, whence it is passed along delicate tubes (tracheæ) to all parts of the system. The stigmata, or openings to the tracheæ, are in the present instance extremely small, and therefore not easy to trace. They are situated on the under surface of the abdomen, not far from the edge of the body. Perhaps the best way to see them is to remove the chitinous band which forms the boundary of any of the central abdominal segments on the under side, and, after relieving it of any adhering viscera, to examine it with the compound microscope. A low power will be sufficient to show the stigmata, one on each side, as minute roundish openings, surrounded by a rim-like lip. From these pass the main tracheal trunks, branches of which, like tiny threads of silver, run hither and thither over the body. Their silvery appearance is due to the air they contain. The

body of the living or freshly killed bug is usually sufficiently transparent for some of the chief branches to be traced from the outside.

The photographs in Plate VII. show the corresponding organs of a water-beetle and a silkworm, and will serve to indicate, more clearly than any verbal description can do, the sort of thing that is to be looked for in a dissection.

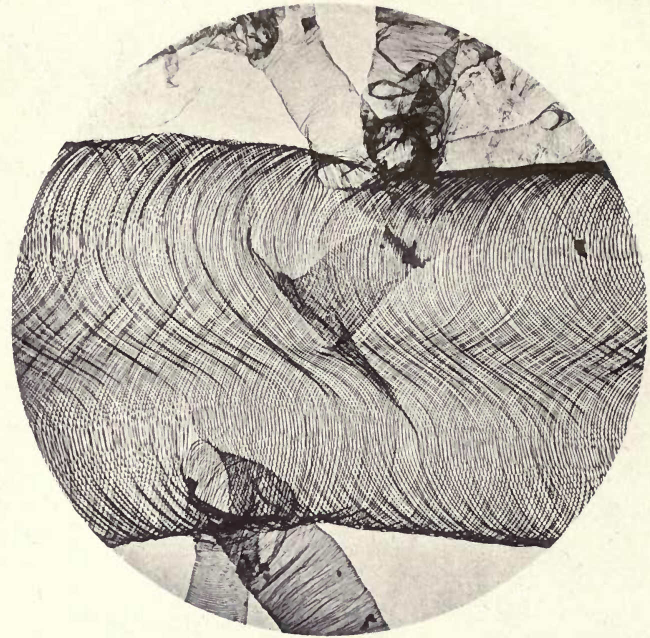
The structural details cannot be properly made out till the tubes are removed from the surrounding organs, and freed from the air they contain. The fine thread which projects round their inner walls prevents collapse; and so well does it perform its function that even in the dead and dried bodies of bugs, however ancient, such as may sometimes be found in swarms behind panels and wainscoting in badly infested houses, the tracheæ can still be recognised as perfect tubes after all the rest of the soft parts have dried up and disappeared. All that it is necessary to do with the dried carcase is to soak it in water till it becomes sufficiently flexible to be manipulated without breaking. On cutting through the skin, the tracheal tubes will be found spreading about in various directions, and may be examined where they lie, or removed and placed between glass, when a high power may be brought to bear upon them. There is no object in insect anatomy that is more easily identifiable than these breathing tubes, or more easily demonstrable, and hardly any that forms a more beautiful and attractive subject of study or exhibition.

Bugs are extremely prolific, and according to Southall, who kept many for observation, sometimes produce eggs as frequently as four times during the course of the summer, whence their remarkably rapid multiplication can be readily understood. The small size of the eggs,

PLATE VII.

TRACHEÆ OF SILKWORM,

Showing main trunk connecting four spiracles, and branching tubes.



PORTION OF TRACHEA OF LARGE WATER-BEETLE.

Showing coiled thread inside the tube.

and the lurking, nocturnal, and obscure habits of the insects themselves, caused their true origin, like that of many another insect pest, to remain for a long time unknown, and indeed unsought. Their constant association with uncleanly conditions resulted in their presence being accounted for by a recourse to that common refuge of ignorance, the doctrine of spontaneous generation, and by this convenient hypothesis the occurrence of all small creatures whose real origin was unknown was explained away, even down to comparatively recent times. So acute and painstaking an observer as Harvey, the discoverer of the circulation of the blood, falls into the commonly received error, and speaks of "grubs and earth-worms, and those that are engendered of putrefaction, and do not preserve their species." In Aristotle's time it was believed that bugs originated from the sweat of animals. And even when we come down to a period of 2000 years later, so full of vitality is error, Mouffet, from whose treatise we have already quoted, states, without any hesitation, and, in fact, with strong asseveration, that they arise from juices which exude from wood, and from putrefying moisture around beds (!); the latter, let us hope, a gross libel on the sanitary arrangements of his time. He mentions also a current popular belief that new bugs arise, hydra-like, from the crushed remains of other bugs—a belief which, one would have thought, would have operated largely in favour of the persecuted; for who would crush one if thereby two were created?

Bugs are extremely tenacious of life, and, being so thin of body, a multitude of them can pack themselves away in the narrowest cracks and crevices, placing their legs in the same plane as the body; hence the difficulty of eradicating them if they once obtain a firm lodgment

in a house. The ordinary insect-powders are of very little avail when they retreat to their narrow hiding-places, between floor-boards, behind wainscoting or loose wall-papers, or in the chinks of the joints of bedsteads, and something which will be more penetrating needs to be employed. Hence one or the other of two methods has chiefly to be relied upon—either the application of a mobile and penetrating liquid, or the production of a noxious vapour. Liquids of the benzine and petroleum type are the best to use under the former head. Dr. Packard recommends an exceedingly simple preparation, consisting of "thirty parts of unpurified cheap petroleum, mixed with 1000 parts of water." Frank Buckland recommended benzine, which he squirted into their hiding-places by means of a small glass syringe, with the effect that they turned out at once, and could be despatched by further applications of the same fluid. The same naturalist describes, with his customary quaintness, a raid he made on kitchen cockroaches with similar artillery: "I took with me an assistant, three glass squirts, and a wide-mouthed bottle of benzol. As the blackbeetles scuttled away to their holes, I kept firing at them, killing some dead, and wounding others, for next morning we found plenty of 'dead birds' about the kitchen. With an active loader to manage the second syringe, and plenty of black game, blackbeetle-shooting at night in the kitchen will give as much sport as rabbit-shooting in a warren by day." Methylated spirit, and diluted carbolic acid, are other liquids that may be employed with more or less success, whilst boiling water is certain death to any that it may reach, in whatever stage of life they may be.

For the vapour method, sulphuric dioxide appears to

be the best insecticide capable of application on the large scale. This gas, which is the cause of the suffocating odour when sulphur is burnt, is easily produced in sufficient quantity by burning a little brimstone in a metal dish. Of course the room to be operated upon must be kept closed as completely as possible during the process, to prevent the escape of the fumes. A *thorough* fumigation by this method may be expected to destroy all that happen to be beyond the egg state; but unless the gas is in a very concentrated condition, the bugs will withstand its action; also further fumigations may become necessary to reach those that were in the egg condition at the time, and do not hatch till afterwards.

In the days of wooden bedsteads, the extermination of these pests was a much more difficult matter than it is to-day. A good four-poster, with all its paraphernalia of trappings, was a perfect paradise for them, and afforded endless retreats in which they could secrete themselves by day, creeping out at night to assail their unconscious victims. Their eradication then became so formidable a business that it was necessary to call in the aid of experts. John Southall himself made bug-hunting his specialty, and evidently regarded himself as a great benefactor to humanity in consequence of the prowess he achieved in this direction. Of course he had a specific of his own, the composition of which he kept a profound secret, relating that he had obtained the knowledge of it from an old grey-haired negro whom he met in Jamaica. On the title-page of his "Book of Bugges" he describes himself, with the customary circumlocution of the period, as the "Maker of the Non-pareil Liquor for destroying Buggs and Nits, living at the Green Posts in the Green Walk near Faulcon Stairs,

Southwark." He seems to have found abundant employment for a considerable staff of employés, who worked under his personal supervision; and his clients were to be found even amongst the most well-to-do classes. His charges were half-a-guinea for ridding the most elaborate bedsteads, and proportionately smaller amounts for those of an inferior style, an ordinary four-poster with plain furniture being undertaken for six shillings.

This was the state of affairs in London about a century and a half ago, and so common was the infliction that it can scarcely have been considered much of a disgrace to be in need of Southall's services. The substitution of plain iron bedsteads for the heavily draped wooden structures used by our ancestors, and the increase of habits of cleanliness in households, have greatly diminished the liability of respectable families to the attacks of these hideous pests, and have therefore been the means of more completely confining them to the poorer districts and slums, where, needless to say, they are still as numerous as ever. Southall charges the builders of his day with introducing bugs into newly built houses, by using second-hand doors, chimney-pieces, &c., obtained from infested dwellings, the eggs of the insects being thus unintentionally brought in; in particular he states that houses in Hanover and Grosvenor Squares were thus supplied before they were inhabited. He undertakes to inspect houses for intending tenants, guaranteeing to determine whether they are infested or not.

Bugs have some natural enemies which might aid in their extermination, were they not themselves too repulsive and annoying to be endured. The cockroach, as already mentioned, devours them, and spiders are said to do the same. There is also an insect called the

fly-bug, which is occasionally found in houses, and preys upon them to a large extent. It belongs to the order Hemiptera, and indeed is not very remotely related to the bed-bug itself. It is called *Reduvius personatus*, and is a large dark-brown insect, about two-thirds of an inch long (Fig. 99). Both pairs of wings are fully developed, and it is a good flyer, being active chiefly at night; it is readily attracted by a light, and hence sometimes flies in at the open windows of rooms in which a light is burning. In its larval and nymph condition it has the remarkable habit of enveloping itself in a coating of dust and bits of rubbish, the whole surface, including legs and antennæ, being thus covered. The antennæ, which are slender, become by this process apparently as stout as the legs, and hence the insect has the appearance of an eight-legged creature, and might be mistaken for a spider, but for the deliberateness of its movements. The refuse matter simply rests on the skin, and may be removed by brushing with a camel's-hair brush. This insect is one of the largest of our British Hemiptera, and is a rapacious creature, entirely carnivorous in its tastes. It destroys various kinds of insects, and the bed-bug amongst the number. Of course the insects are not devoured; they are pierced by the short proboscis or rostrum, which is constructed similarly to that of the bed-bug itself, and only their juices sucked out.

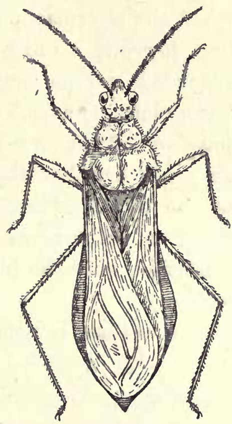


FIG. 99.—The Fly-Bug (*Reduvius personatus*), a destroyer of Bed-Bugs.

Several plants were formerly used as cimicifuges, their

smoke, when burnt, being believed to be obnoxious to the insects. Cow-dung and horse-hair were used in a similar way. Superstition and credulity went so far as to place confidence in the occult influences of such objects as stags' horns, rabbits' feet, foxes' ears, &c., when hung up near beds.

So disgusting an insect as *Cimex lectularius* could not fail to have medicinal virtues attributed to it at a time when the pharmacopœia contained multitudes of nameless horrors. Pliny states that it was in his time regarded as an antidote to the bite of serpents, "especially of asps," adding that fowls which had eaten bugs would not be injured if bitten on the same day by an asp. Another Roman author says that an infusion of the bodies of seven crushed specimens was administered to patients who were sinking into an insensible condition, with the intention of rousing them from their lethargy!

The bed-bug is not the only species of its genus that is found in this country, though by far the commonest. Three others have been described, none of which, however, are to be regarded as directly parasitic on man, though some of them, and probably all, do not object to a meal of human blood when they can get the chance. One is found in pigeon-cotes, where it attacks the birds, another in martins' nests, and the third in bats' nests. They are all very much alike, and closely resemble our domestic pest. The first two may sometimes be found climbing the walls of houses, or on window-sills, in the neighbour-

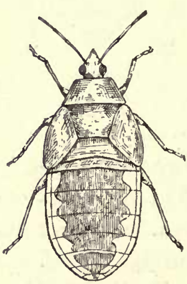


FIG. 100.—Nymph of *Lyctocoris campestris* (sometimes mistaken for Bed-Bug).

hood of dove-cotes, and under martins' and swallows' nests.

Besides these, another insect (Fig. 100) is, in its larval condition, sometimes confounded with the bed-bug. It is commonly found in barns amongst the miscellaneous rubbish that accumulates on the floor, as well as under and around haystacks, &c. It is called *Lyctocoris campestris*, and is an outdoor insect, and may be found in hedges amongst dead leaves and other *débris*. In its perfect condition (Fig. 101) it could not be mistaken for our domestic pest, as it is fully equipped for flight, both pairs of wings being completely developed. But in its immature stages it certainly does present a superficial resemblance to the corresponding forms of its not very remotely connected ally. Reddish brown in colour, it is, however, smoother and more elongate than the bed-bug, as well as considerably smaller. It is not parasitic, and is therefore harmless.

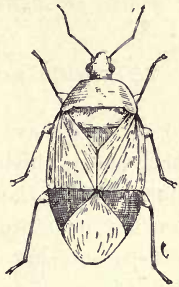


FIG. 101.—*Lyctocoris campestris*, in its perfect winged form.

CHAPTER XVI.

THE BOOK-LOUSE AND SILVER-FISH INSECT.

To all who have the care of collections of insects or other natural history specimens, there has come, at some time or other, the vexation of seeing on the bottom of drawers or store-boxes some swiftly running, almost transparent, but exceedingly minute, insects, rushing about from one specimen to another, playing hide-and-seek, as it were, under them, in a manner most provoking to their owner. They are there for no good purpose, and must be ruthlessly hunted to death, for they are the destructive creatures known as book-lice (*Atropos divinatoria*), an extremely familiar and much-detested pest. Without strenuous and persistent efforts it is impossible to protect specimens, whether animal or vegetable, from their depredations; and though so minute, *Atropos* is none the less capable of causing serious damage if allowed to go on its way unchecked, as many have found to their cost, who have permitted the quarantining of their collections to be intermitted for a time. Its popular name is a somewhat unfortunate one, since the suggestions of unpleasant associations which it conveys are altogether unfounded in fact. The little creature is not parasitic, and becomes a pest solely by reason of the readiness with which it will attack and devour anything that is in the least degree edible. It is a widespread and common inhabitant of houses, there

being probably few from which it is entirely absent. Its minuteness, however, is an effectual means of concealment, and its presence is usually unknown and unsuspected.

The accompanying illustration (Fig. 102) will give an idea of its form, but it is so small that no details of figure can be definitely made out in a living specimen except by aid of a lens, its length when full-grown not exceeding one-twentieth of an inch. Hence it is hardly likely to be recognised from its portrait, except by those who are accustomed to the constant use of the hand-lens, for to the naked eye it appears as little more than a rapidly gliding short streak, or an animated scrap of thread. It is semi-transparent, and has little colour except when mature,

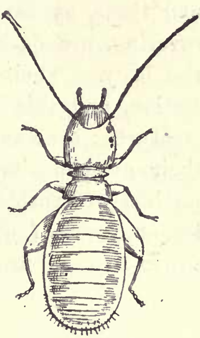


FIG. 102.—Book-Louse (*Atropos divinatoria*).

at which time a brownish grey or smoky tint is perceptible over its back. The head is remarkably large when compared with the body, and carries, amongst other organs, two long, many-jointed antennæ of wonderful thinness, finer than the most delicate of hairs, and a small pair of black eye-masses, one at each side, inclining towards the upper surface, and not at all prominent.

The front of the head is considerably swollen above, a feature which becomes evident when a profile view is obtained (Fig. 103). Its ex-

FIG. 103.—Side View of Head of Book-Louse.

treme tip, or nose, as it is sometimes called, has a ruddy tinge. A pair of palpi, which, like the antennæ, are in

incessant vibration whenever the insect moves, can be seen from above, projecting forwards from the front margin of the head, the real point of attachment being, however, below, on the secondary jaws or maxillæ. A strong pair of short, stout, primary jaws (mandibles) constitute the only weapons of offence, and these, as having a greater thickness of chitinous covering, are darker coloured than any other part of the body. Their shape cannot be seen without dissection, and this is no easy matter with such minute creatures; they can, however, be easily separated from their attachments by the somewhat rough-and-ready method of crushing the delicate little being between two surfaces of glass; on running in a drop or two of water to clear away the fragments of soft tissues, they may be isolated, and their outline can then be readily traced. Fig. 104 shows their form, regularly curved on the outer edge and toothed on the inner. They work across one another like the blades of a pair of scissors.

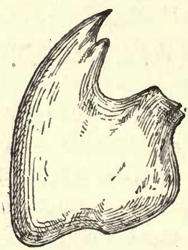


FIG. 104.—Mandible (Jaw) of Book-Louse.

The thorax is the narrowest part of the animal. The usual three divisions are of course present, but they seem like two, as the hinder two are united into a single piece, which is, however, quite separate from and movable upon the prothorax, which in its turn forms a kind of narrow collar stretching across just behind the head. The legs are attached to the three divisions beneath, one pair to each; they are remarkable for the thickness of the thighs, which in the hind pair are extraordinarily broad, presenting an appearance such as usually indicates the possession of leaping

powers; the habits of the insect, however, do not bear out this indication. The remaining part of the legs is in each case slender and almost transparent, and the feet consist of three joints only, terminated by the usual pair of claws. As with some other of our household insects, no wings are developed, though most species of the group to which it belongs have the full complement. A long, stout, but soft-skinned abdomen succeeds the thorax, a little broader behind than in front, and bluntly rounded at the end, where a few bristles project.

Very little change takes place in the form of the insect during the course of its life, and it is at all times active, never losing its limbs to become a quiescent chrysalis, and belonging therefore to that section of the class Insecta in which the metamorphosis is incomplete, the division to which the cockroach and bed-bug also belong. When quite young it has but two joints to its feet, instead of three, and at the same time the number of joints in the antennæ is smaller than when fully grown.

As regards systematic position, it belongs to a family which includes several insects that are extremely abundant, but at the same time almost entirely unknown to any but professed entomologists, and hence have no popular names. The family is called *Psocidæ*, and most of our British species are pretty little winged creatures of delicate structure, in appearance something like Aphides, or plant-lice. Some are found in profusion running about over palings and fences, or on the trunks or branches of several kinds of trees, especially those of the pine and fir tribe. If the branches of a larch or Scotch fir, for example, be shaken over a sheet of paper, numbers of little creatures belonging to this family will fall out. The family *Psocidæ*, again, is reckoned as coming within the domain of the order Neuroptera (nerve-

wings), an order which we have not hitherto met with amongst our domestic pests. It is a very mixed assemblage, containing, for want of a better arrangement, in addition to the *Psocidæ*, such insects as the lace-wing flies, scorpion-flies, May-flies, white ants, and, according to some authors, dragon-flies as well. The most uniform and characteristic feature of the majority of these insects is that the nervures of the wing are extremely

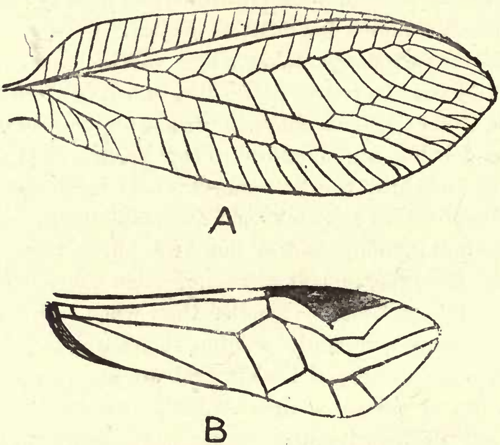


FIG. 105.—A. Fore-wing of Lace-wing-Fly (*Chrysopa vulgaris*).
B. Fore-wing of *Psocus longicornis.*

numerous, dividing its surface into so large a number of minute areas that it appears to be covered with a small-meshed network, whence the name Neuroptera. The *Psocidæ*, however, are but an outlying section of this group, and do not exhibit such a minute subdivision of the wing surface, as will be seen by comparing the accompanying illustrations of the fore-wings of a lace-wing fly and a *Psocid* (Fig. 105). For this reason, these insects have sometimes been spoken of as *Pseudo-*

Neuroptera, i.e., false Neuroptera. If *Atropos* were ever found with wings, they would no doubt be of the nature of the second figure rather than of the first; but no such occurrence is known; if, on the other hand, the winged *Psocidæ* were deprived of wings, they would somewhat resemble *Atropos*, and in their earlier stages, when they are wingless, they do actually exhibit a tolerably close approximation to it. These facts are a sufficient justification for including it in the same family.

The book-louse is most abundant in summer time, when it may be found, not only in neglected collections of animals or plants, but in cupboards, on window ledges and library shelves, and generally amongst old books (whence its popular name) or stores of any kind, and the more undisturbed the stores the more the insects will flourish. With their stout little jaws they sometimes do considerable damage to books, dried plants, insects, &c., nibbling away at the leaves and covers of the former, and destroying all the smaller and more easily accessible portions of the latter. Farinaceous substances seem to be peculiarly acceptable to them, and one of the most flourishing colonies that have come under my notice was in a small quantity of "oat flour," which had been left for some years in a tin canister. The little creatures had the store all to themselves, and were perfectly revelling in it.

They are very interesting little things to watch the movements of, and this is easily done by enclosing them in a glass-topped box, and examining them under a low power, say a two-inch objective, of the compound microscope. There is a sprightliness and apparent intelligence about their actions which is quite surprising in creatures of such very minute size; and as one gazes at them down the tubes of the instrument, one cannot help

thinking that if they were but a little larger, they might be made pets of, and become quite companionable. One habit they have which is extremely curious. After running about for a time, they will suddenly stop, arch up the body, and raising one hind-leg, bend it under the arched body, and, like the ear-wig, turn it round towards the mouth, pressing the foot close against the jaws; what they do with it there it is difficult to make out, but they remain in this position for some seconds, and seem to be occupied in nibbling at the foot, like a dog biting the nails of its hind-foot, and are apparently either cleaning it or using it to clean the jaws and other parts immediately round the mouth. That a *fore*-foot should be used in this way would not be at all surprising, but it is certainly a curious acrobatic feat thus to employ a *hind*-foot.

The most interesting circumstance connected with the book-louse is the reputation it has of being a "death-watch," *i.e.*, of producing a ticking sound, formerly believed to be of ominous import, and to prognosticate the speedy death of some inmate of the house in which it occurs. The beetle, *Xestobium tessellatum*, which tunnels into the woodwork of old houses, produces, as we have already seen, such ticking sounds, and is the true "death-watch," the tappings of which were for a long time regarded with awe, and have grievously frightened many a superstitious soul. But the present insect, which is an altogether different creature, has also been credited with a similar habit, and there has no doubt been much confusion between the two, as both have been called "death-watch." The Rev. William Derham of Upminster was the first in this country to place on record statements attributing such noises to *Atropos*. He communicated two papers on the subject

to the Royal Society, in which he roughly described and figured the insect, and detailed his own observations. These papers may be found in the Philosophical Transactions for the years 1701 and 1704. He is careful to distinguish the insect, as regards its form and the character of its beating, from the ticking beetle above referred to, the habits and form of which had been described and illustrated in a paper from which we have already quoted, and which was presented to the same society a short time before by Mr. Benjamin Allen. Derham gives the subject of his observations the name of *Pediculus pulsatorius* (the drumming-louse), but there can be little doubt that it was the same as that now called *Atropos divinatoria.*

He especially notices its minute size, saying that he was obliged to use a magnifying glass to watch its movements and habits. He points out, further, that whilst the death-watch *beetle* beats only seven or eight strokes at a time, and quicker, "the other will beat some hours together without intermission, and his strokes are more leisurely, and like the beats of a watch." The ticking was hardly ever heard except in July and August, and was much more frequent in some seasons than in others. In the year 1702 "they ticked very much, scarce ever ceasing day or night," but the next year they were far less active, and the sound was rarely heard. The insect produced the sound by beating the front part of the head against the object on which it was resting; and Derham regarded it as in some way connected with the mating period—a sort of love-call—which would account for its being heard only at certain seasons. These two points form, indeed, as already mentioned, the correct explanation of the ticking of the true death-watch, and so far are, therefore, possibly operative causes in other

instances as well, and are such as might readily be admitted in the present case, if it could be shown that the insect possesses the requisite mechanism. But it is just here that the difficulties come in: the extremely minute size of the insect itself, and the softness of its body, seem to be sufficient reasons to preclude the possibility of its being the author of such ticking sounds. The death-watch beetle is covered with an extremely hard integument, and is, moreover, not very minute, being about a quarter of an inch long; and it is easy to understand how blows given by its hard head against timber are sufficiently violent to be audible as repeated taps or ticks. But such is by no means the case with the book-louse, and it is difficult to understand how an insect so soft as to be crushed to death by the slightest pressure, and so minute as to require a lens for the purpose of observing even its true form, can by any mechanical means at its disposal produce a sound loud enough to be audible at all, much less at a distance. It is true that the jaws are the hardest part of the body, and these, it is said, are the parts by which the noise is made; nevertheless, one would suppose that the impact of such minute specks upon any substance whatever would, except under the most favourable conditions, be quite inadequate for the production of any sound that would be audible without the aid of a microphone.

However, Derham was very positive in his statements, and since his time several other observers have recorded somewhat similar experiences, from which we may quote the following as perhaps the most circumstantial and apparently convincing. It is a record by Mr. J. Blackwall in the *Entomologist's Monthly Magazine* for 1867: "A ticking sound, so precisely similar to that of a watch as scarcely to be distinguished from it by the nicest

discrimination, was perceived to proceed from a small work-box, comprising several compartments. Now, as this very remarkable noise, which differs widely from the tapping sound produced by *Anobium tessellatum*, is supposed by many persons to be caused by some species of spider, I resolved to investigate the phenomenon; accordingly, having placed the work-box on several sheets of writing-paper, I proceeded to open the compartments in succession, examining each, with its contents, in a good light, assisted by the employment of a large lens. After having carefully inspected the compartment first opened, a pause ensued, till the sound, which had been interrupted, was renewed. Proceeding cautiously in the manner described, the ticking sound was ultimately traced to the last compartment, which served the purpose of a pincushion, and was filled with bran. On the cover being withdrawn, the bran was removed in very minute quantities to a sheet of writing-paper, each portion, when lightly spread by means of a feather, being closely examined under the lens. The only occupant of the box detected by this complete scrutiny was a living *Atropos pulsatoria;* and I think the facts of the case fairly warrant the deduction that the ticking sound was produced by it, more especially as no such sound was ever after heard to emanate from the box. I may add that the *Atropos*, which was placed in a clean phial, died in the course of an hour, without emitting any perceptible sound."

The insect called *A. pulsatoria* in the above extract is the same as what is now known as *A. divinatoria*, and the evidence is obviously so strong in its favour that it is only the very great mechanical and acoustical difficulties involved that cause one to hesitate about accepting it. To those, moreover, who have known these insects for

many years, and have more or less continuously had them under observation, and yet have never heard the slightest sound proceed from them, it may perhaps be allowed to be still somewhat sceptical.

Another kindred insect sometimes accompanies *Atropos* in its burglarious visits to insect collections. It is a rather larger creature, with more prominent eyes, and with roundish scales in lieu of wings. It is called *Clothilla pulsatoria.* Another, still larger, of a blackish colour, may also very occasionally be found in extremely neglected collections, especially of foreign insects. It is known as *Clothilla* or *Lepinotus picea.* There is a family likeness about these insects that is unmistakable, and renders them easily recognised, and they can scarcely be confounded with the larger, more rotund, and slower eight-legged mite, which is even a worse enemy to collections of dried insects.

Our next example of household insects is the silver-fish insect. This curious little creature has had a varying reputation, at one time being regarded as harmless, and at others accused of causing serious damage. There is abundant evidence to show that the latter is the true view, and we are therefore justified in including the silver fish in the list of our domestic pests. Scientifically it is known as *Lepisma saccharina,* and its popular names, which are numerous, such as silver witch, sugar fish, wood fish, sugar louse, bristle-tail, and silver fish, refer to different details of its structure or habits. It is an elongated, flattened, conical, or fish-shaped, wingless creature (Fig. 106), with six legs, two long antennæ, and three long, bristle-like organs by way of tail; the whole being of a bluish or greyish silvery lustre, tinged with yellowish colour about antennæ and legs. The

silvery appearance is due to vast numbers of minute scales with which the body is covered, and which are well known to microscopists as test objects, closely allied to the celebrated *Podura* scales. The insect is about one-third of an inch long, and is not unfrequently found in houses, though apparently less commonly now than formerly.

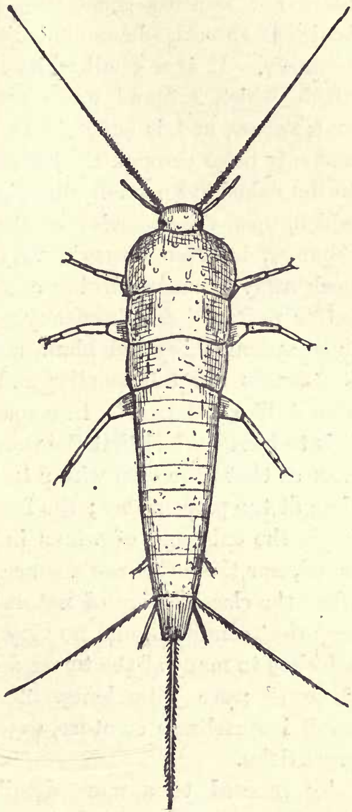


FIG. 106.—The Silver-fish Insect (*Lepisma saccharina*).

The earliest notice of this little creature is to be found in a curious book, entitled "Micrographia," published by R. Hooke in 1665, at the instance of the Royal Society, to detail some of the first observations made in this country by means of the microscope. In this book, which represents a good deal of careful work, the insect is called the "Small Silver-coloured Book-worm," and, after the manner of the times, an enormously magnified figure is given, executed with great care, and sufficiently accurate to be easily recognisable. Hooke's notice of the insect is introduced

as follows: "As among greater Animals, there are many that are scaled, both for ornament and defence, so are there not wanting some such also among the lesser bodies of Insects, whereof this little creature gives us an Instance. It is a small white Silver-shining Worm or Moth, which I found much conversant among Books and Papers, and is suppos'd to be that which corrodes and eats holes through the leaves and covers; it appears to the naked eye a small glittering Pearl-colour'd Moth, which, upon the removing of Books and Papers in the Summer, is often observ'd very nimbly to scud, and pack away to some lurking cranney, where it may the better protect itself from any appearing dangers. Its head appears bigg and blunt, and its body tapers from it towards the tail smaller and smaller, being shap'd almost like a Carret." In connection with this extract it is to be remarked that the words "moth" and "worm" were at that time used with a less restricted signification than at the present day; the former did not necessarily imply the existence of wings in the animal so denominated, nor the latter the absence of legs. It was a time when the classification of natural objects was in a most imperfect condition, and no very definite conception was attached to many of the terms employed. "Moth" and "worm" were interchangeable words, implying any small invertebrate creature, especially if of destructive proclivities.

To proceed to a more detailed examination. The insect consists of a head, three segments constituting the thorax, and eleven composing the body. The rounded head, as already mentioned, carries two long slender antennæ, composed of a multitude of minute joints, and pointing forwards. They are generally more or less imperfect, from damages received in consequence of the

delicacy of their structure. When complete, they are about two-thirds the length of the body. There are also two little black heaps of eyes, one at each side. The usual mouth parts are present, and there are two pairs of palpi—the maxillary, five-jointed, and the labial, four-jointed (Fig. 107). The mandibles, or biting jaws (Fig. 108), are long and narrow, and toothed at the free end with several hard prominences. All three thoracic segments are of large size, being, in fact, both the widest and longest segments in the whole insect. The prothorax is the largest of the three, in marked contrast to the last pest we considered, the book-louse, where it was the smallest. Each of these three segments, as usual, carries a pair of legs, consisting of the customary parts, and each terminated by a pair of claws. No wings are ever developed, nor are any traces of such organs ever perceptible. The abdomen consists of a series of segments tapering gradually towards the tail, the last one carrying three long, bristle-shaped appendages. The skin is of a delicate texture, and is covered with multitudes of minute iridescent scales of exquisite structure (Fig. 109), closely resembling those of butterflies, and readily

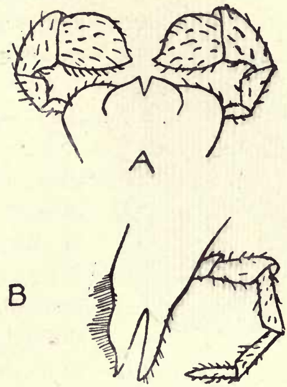


FIG. 107.—A. Labium and Palpi of *Lepisma*. B. Maxilla and Palpus of ditto. (After Lubbock.)

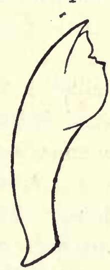


FIG. 108.—Mandible of *Lepisma*. (After Lubbock.)

detached by a touch. These are the cause of the silvery appearance, and produce a very slippery surface, which, combined with its extraordinary agility, makes the silver fish a difficult creature to catch and hold.

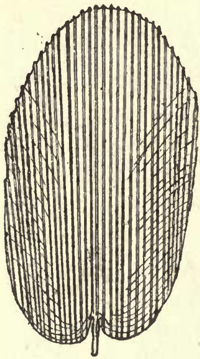


FIG. 109.—Scale of *Lepisma.*

Like other animals belonging to the Arthropodous (jointed-legged) division of the animal kingdom, the silver fish sheds its skin periodically, thereby providing for an increase in size; but apart from the slight changes produced by this regular renewal, its appearance is not altered throughout life. When hatched from the egg, it has six fully-developed legs, as when mature, and is similar in form, differing only in the proportions of the parts and in depth of colour. As there is no quiescent stage corresponding to the pupa of other insects, and no acquisition of wings, the silver fish may be truly said to undergo no metamorphosis. And the same remark applies to all the members of the group to which it belongs; none of them ever possess wings or exhibit that succession of changes of form to which the name "metamorphosis" is applied. We have here, then, quite a different case from that of the bed-bug or book-louse. These were apterous members of groups which are normally winged in the adult stage. The silver fish, on the other hand, belongs to an order which is normally apterous throughout life. This order is called Thysanura, and, as restricted by Sir John Lubbock (*i.e.*, without the Collembola, or springtails, small jumping insects found in profusion under stones, logs of wood, &c.), contains only a very few British insects. Three only are likely

to have been generally noticed, viz., the present one; a similarly shaped but considerably larger brown one, found amongst heaps of stones near the coast; and a minute, pale, yellowish-white creature with two long tails, which may be found under stones that have lain long on soft damp ground. A special interest attaches to this last (*Campodea staphylinus*), seeing that, in the words of Sir John Lubbock, "there are good grounds for considering that the various types of insects are descended from ancestors more or less resembling the genus *Campodea*. . . . If these views are correct, the genus *Campodea* must be regarded as a form of remarkable interest, since it is the living representative of a primæval type, from which not only the Collembola and Thysanura, but the other great orders of insects have derived their origin." Some naturalists regard the Thysanura as allied to the Neuroptera, including them amongst that section of the order called Pseudo-Neuroptera.

Little need be said as to the digestive system, since it is constructed on the usual insect type. The alimentary canal is a straight tube running through the body. The gullet enlarges into a crop, which is succeeded by a grinding apparatus, in the form of a globular gizzard furnished with six tooth-like projections; after this comes the true or digestive stomach, succeeded again by the intestine, at first narrow, but in its hinder part broader; the Malpighian tubules are four in number. When contemplating the functions of the silver fish in nature, Hooke, the author of the *Micrographia*, falls into the following curious reflections, very characteristic of the physiological ideas of the times in which he lived: "When I consider what a heap of Sawdust or chips this little creature (which is one of the teeth of Time) conveys into its intrals, I cannot chuse but remember and

admire the excellent contrivance of Nature in placing in Animals such a fire, as is continually nourished and supply'd by the materials convey'd into the stomach, and fomented by the bellows of the lungs; and in so contriving the most admirable fabrick of Animals as to make the very spending and wasting of that fire to be instrumental to the procuring and collecting more materials to augment and cherish itself, which indeed seems to be the principal end of all the contrivances observable in bruit Animals." The nervous system is of the usual type, consisting of a pair of ganglia above the gullet, in the head, and a chain of eleven pairs down the body, beneath the digestive apparatus. The little creature breathes by means of tracheæ, like other insects, and some of these may be seen through the skin during life, or immediately after death, especially those running down the legs.

Lepisma saccharina is essentially a vegetable feeder, and the substance most in accord with its taste is apparently starch. This preference makes it sometimes a by no means insignificant foe; for starchy substances are so largely used in connection with books and papers, that *Lepisma* may do serious damage in libraries and museums if not carefully guarded against. Several instances of this are on record, and doubtless many more might be collected if the foe were more generally known and more easily detected in the act of marauding; but as it is a lover of darkness and concealment, and easily takes alarm, rapidly slipping away in a weird ghost-like manner when interrupted, it is frequently difficult to obtain anything more than circumstantial evidence of its depredations. In 1879 Professor Westwood exhibited to the Naturalists' Association a print, the plain border of which had been eaten in holes by

Lepisma, while the parts covered by the printing-ink had been left untouched. In India, Government records have been similarly damaged; for this insect is very generally distributed, and reports of the injuries it has caused come in from all parts of the world. The paste used in bookbinding or in papering walls forms a prime attraction to these starch-loving creatures, and its age is a matter of little importance: the oldest and driest seems as attractive as the newest and freshest. Hence they do damage to the bindings of books and to paper-hangings, often eating holes in the paper, either for its own sake or for the sake of the paste behind. I once had an unpleasant experience in this direction: a large case of transparencies, made of different thicknesses of paper pasted together, had been laid aside for some years, when, on being opened, a colony of *Lepisma*, that had evidently discovered and been revelling on the store, hurriedly scuttled away into remote and dark corners. On inspection, it was found that while comparatively little damage had been done to the paper itself, only the thinner parts having been nibbled, yet in many places the paste that united different thicknesses had completely disappeared, the papers in consequence falling apart and hanging in tatters. Muslin curtains, again, have been attacked in consequence of the starchy stiffening in them, and eaten in holes. Similarly, starched collars, cuffs, and other articles of clothing have been damaged. Silk garments and silken tapestry have also suffered, the material in this case being destroyed, apparently not so much for itself as for the stiffening it contained. In 1882, Gustav de Rossi complained that *Lepisma* had eaten holes in a carpet, in the dust-covers of chairs, and other furniture, in the paper lining of an insect store-box, and lastly

in the wings of such specimens as it could reach in a rather carelessly preserved collection of butterflies. Some of these last instances evidently indicate that the silver fish, though very partial to vegetable matter, is quite prepared to seek its food in the animal kingdom should the opportunity be afforded.

Some of the most curious and annoying of the damages wrought by this insect have taken place in museums, where the inscriptions on the labels of specimens have been rendered illegible by their little jaws, though the labels themselves have been left intact. One such instance is recorded by Dr. Hagen from the Geological Museum at Boston, U.S.A. A new form of label, printed on good card, had been employed for re-labelling the collection. The specimens being kept in little square boxes, the ticket was folded in half, one portion being placed under the stone, whereby it was kept in place, while the name of the specimen and its locality were written on the upturned half. The whole collection having been thus neatly labelled, in the course of the next twelvemonth the surfaces of the cards gradually changed in appearance, looking as if they had been scraped, many of the inscriptions being in consequence completely destroyed, and others partially obliterated. The change being a gradual one, and no foe of course being visible, as the work of destruction was done at night, it was at first a puzzle what could be the cause. After a while, however, the culprit was discovered in the shape of a certain species of *Lepisma*, not quite the same as our *L. saccharina*. The insects had evidently been attracted by the superior finish of the labels, the glaze on which, composed of starch, had proved so strong a temptation to them, that every exposed part was scraped, the only portion left

untouched being that on which the specimen was actually resting, which was of course inaccessible. Labels of ordinary common writing-paper had not been attacked. The damage done was a serious one, as the whole collection had to be re-labelled, and in such cases the loss sustained may be far more serious than the mere cost of a set of cards, since, the use of the specimens depending to a great extent upon the details of locality, &c., if these be obliterated and not recoverable, their value is much diminished. Another instance is from the Museum of the Jardin des Plantes, Paris. Here some white labels had been printed with a red border, the colour of which was due to red lead. The white parts of the labels were eaten away, but all the red parts were left untouched, the pattern being sometimes neatly picked out. A third instance occurred in a museum in New South Wales, where some hundreds of labels were, after only fifteen months, rendered useless. It is evident that loose papers are much more obnoxious to the attacks of the silver fish than those that are closely packed, there not being room in the latter case for so large an insect to creep between the leaves; hence an obvious and useful precaution would be to keep all separate papers, where possible, tightly packed together.

The case of books is particularly unfortunate, for the wood-loving beetle, *Anobium*, which makes furniture worm-eaten, will also attack the covers and leaves of books, boring holes in them; but it does not like starch, hence it has been proposed to use paste made of that substance as pure as possible in binding books. But it now appears that by so doing they will be made, though distasteful to *Anobium*, only all the more acceptable to *Lepisma*. It does not appear to be always so easy to

keep out this foe of books as one might have imagined; even an iron safe has been found insufficient to protect the treasures enclosed therein, for in the year 1885 Mr. R. Adkin exhibited, at a meeting of the Entomological Society, a *Lepisma* of some kind which was found swarming on some account books that were constantly kept in an iron safe in Aldgate, London. Visions of the possible erasures which might thus be effected in important legal documents are not reassuring, and show *Lepisma* to be an enemy to which no quarter must be given. Perhaps one of the strangest spots in which the silver fish has been found is old martins' nests, where on one occasion M. Cornelius discovered more than forty examples in the middle of winter.

CHAPTER XVII.

HUMAN PEDICULI.

If occasional parasites, such as fleas and bugs, creatures which simply visit our bodies at intervals, and spend only a small proportion of their lives actually on our persons, excite repugnance and disgust, what can be said of the feelings with which we contemplate those hideous pests that make men's bodies their lifelong home, born and bred thereon, generation after generation, living there and there alone, and, as units of life, almost, if not entirely unknown, apart from such association? And yet, though cleanly people nowadays hold them in such utter abhorrence that they can hardly be named in polite society, they were not always objects of loathing and disgust. In former times people were more inclined to joke about them than to shudder at them, and some, it is said, even went so far as to be proud of their guests. In Hooke's "Micrographia," which, as we have already seen, was written some 230 years ago, there is a brief account of the head-louse, accompanied with an enormous figure representing a specimen magnified to the length of nearly two feet. Hooke introduces his description with the following highly suggestive passage:—"This is a creature so officious that 'twill be known to every one at one time or other, so busie, and so impudent, that it will be intruding itself in every one's company, and so proud and aspiring withall that it fears not to trample on the best, and affects nothing so much as a Crown;

feeds and lives very high, and that makes it so saucy, as to pull any one by the ears that comes in its way, and will never be quiet till it has drawn blood." Whatever we may think of the good taste of this passage, and the quaint conceit it contains, it is evident that personal cleanliness was not considered in the days of the Stuarts a matter of such vital importance as it has come to be regarded by respectable society in the Victorian era, and visions of the shady side of domestic life in the time of the "Merry Monarch" are called up, which it is as well to draw a veil over.

Man is not exceptional amongst mammals in harbouring these vermin, he is but in the same category with the rest; for it seems to be the rule, from elephant to mouse, largest to least, that some member of this group of parasites should be attached to each species; and even aquatic mammals, such as the seal and walrus, do not escape their attacks. But just as the human flea is not the same as those of other animals, so human lice are distinct from those which infest the lower mammalia, and indeed each species of mammal may be expected to have its own distinct parasite. Man, then, is not exceptional in *suffering* from these parasites, but rather in having to some extent, as has taken place amongst civilised nations, shaken himself free from them.

Of these disgusting insects three species are known to infest human beings, the head-louse (*Pediculus capitis*), the body-louse (*P. vestimenti*), and the crab-louse (*Phthirius inguinalis*). The first is the kind that occurs most commonly, and the last is the rarest. The two *Pediculi* are very much alike, the body-louse being best distinguished by the locality in which it is found, and by its larger size; the *Phthirius* is very different from both. Taking as our type the commonest species (Fig. 110), we

may first note its structural peculiarities. It is a flattish, semi-transparent insect, of a pale ashy-grey colour, with a comparatively small head and a very large body. The head, which is narrowed in front and behind, carries a pair of short, five-jointed antennæ, a pair of simple, rounded, unfaceted eyes, and the mouth organs, of which more presently. Behind it merges into the thorax, which again is not definitely marked off from the abdomen, but the three pairs of legs show how far its three segments extend. The legs succeed one another without interval, and the first pair are placed immediately behind the head. No wings of any kind are ever developed, nor is any trace of such organs perceptible; hence some naturalists have questioned whether the lice should be included amongst insects at all. Not only is the thorax considerably broader than the head, but this increasing breadth is continued into the abdomen, so that the widest part of the insect is about half-way down the body. The margins of the abdomen show a scalloped edge, there being a series of indentations where the segments adjoin. On each of these rounded projections is placed a small circular

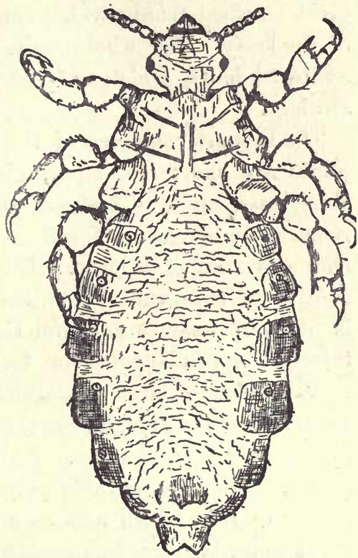


FIG. 110.—Head-Louse (*Pediculus capitis*). Female, viewed from beneath. Magnified 22 diameters.

spiracle, or breathing hole, the terminal orifice of a short tracheal branch. Six spiracles are thus arranged along each side, and the short branches from them join two great tracheal trunks which run parallel to the margins of the body. The whole body is covered with minute scattered hairs, which are sharp-pointed and perfectly straight.

The legs are composed of the usual parts, but all the joints are short and stout, giving an appearance of clumsiness, and the feet are extremely peculiar, their remarkable structure forming one of the distinctive characteristics of a louse. The tarsus, or foot proper, consists of two small joints, the division between which is not very easy to see, and these are succeeded by a terminal appendage in the form of a single, curved, movable claw of large size, which is usually carried bent more or less inwards, and is capable of being completely folded back upon the foot. At the end of the tibia, or shank, there is a movable pointed prominence, and by means of this, which acts as a sort of thumb, and the great claw, the insect is enabled to exercise that strong grasping and clinging power for which it is noted, and which is of great importance in its economy, facilitating its movements amongst the hairs in the midst of which its life is spent. In the figure one of the claws is shown bent back upon the "thumb" as in the act of grasping. The claws are very similar in shape to those of fleas, but differ in being single on each foot, instead of double.

In the structure of the mouth organs again, lice are exceptional. When the dead or inactive insect is examined, no mouth organs can be seen, for, when not in actual use, they are retracted within the head. The mouth is of the suctorial type, the insect feeding on the blood of its victims, to obtain which, an incision

must of course be made through the skin. But, in consequence of its retractile character, there has been a great deal of difficulty in determining the real structure of the sucking apparatus, and it is necessary to carry out careful observations on the living or recently killed insects, before the details can be made out. The old Dutch naturalist Swammerdam took great pains in investigating the matter, and showed clearly that there was a suctorial proboscis, which could be thrust out from the head and entirely retracted again. But, as he himself says, "this proboscis is, on account of its diminutive size, not to be demonstrated except with great painstaking, and it is perhaps nothing but a piece of good luck if one succeeds in seeing it." This being the case, it is perhaps not surprising that since Swammerdam's time some authorities have denied the exclusively suctorial character of the apparatus, and have maintained that true biting organs are present, whence they attributed the irritation produced by the insects on their hosts to the effects of a real pinching bite. This, however, was a mistake, arising from the fact that only dead specimens were examined, and those, too, under pressure, so that the apparatus could only be seen through the skin as it lay contracted inside the head, in consequence of which it was misinterpreted. About twenty-five years ago Professor Schiödte, a Danish naturalist, by careful observations on the living insect (in this case *P. vestimenti*), confirmed Swammerdam's statements, and determined with greater accuracy the true nature of the proboscis. He obtained an abundant supply of material from a workhouse (Danish), and having enclosed some specimens in a glass tube for two or three days without food, so that they might the more readily fall to when released from confinement, he

transferred one of them to the back of his hand, and prepared to watch its movements with a lens. He thus describes what followed: "Scarcely does the abominable little monster feel the heat of the skin before it lays aside its former disheartened attitude, and begins to feel at ease, its antennæ oscillate for joy, and it stretches all six legs complacently out from the body. But though the pleasure and surprise at the sudden transportation into congenial surroundings for the first moment eclipse everything else, hunger soon asserts its claim, sharpened as it is by the long fast, which has rendered its stomach and intestines quite transparent. The animal raises itself on its legs, walks on a few steps, seeking and feeling its way with its antennæ, while we follow it with the magnifier. Presently it stops, draws in its legs a little, arches its back, bends the head down towards the skin at an oblique angle, while it pushes a small dark and narrow organ repeatedly forward, and draws it back through the fore end of the head; at last it stands still, with the point of the head firmly abutted against the skin." While the animal was in this position, he seized it gently with forceps, and endeavoured to detach it from the skin, hoping thus to see the extended proboscis. But in this he was disappointed, for though a slight resistance to his efforts was experienced, showing that the proboscis had really penetrated the skin, yet when the insect was detached, no trace of a proboscis, or anything of the sort, could be seen; it had instantly shot back into the head, and returned to the normal position of rest. This method, therefore, having proved ineffectual, the experimenter decided for a time to confine his observations to the upper surface of the insect during the progress of its meal, so as to watch, through the transparent skin, the

gradual drinking in of the blood. Allowing it, therefore, to attach itself once more, he sees "at the top of the head, under the transparent skin, between and a little in advance of the eyes, a triangular blood-red point appear, which is in continual movement, expansion and contraction alternating with increased rapidity. Soon this pulsation becomes so rapid that several contractions may be counted in a second." Swammerdam also had noticed this, and likened the rapid movements of this little pumping machine to the quick oscillation of the balance-wheel of a watch. Schiödte continues, "The whole digestive tube is now in the most lively peristaltic movement, filling itself rapidly with blood, as is easily observed; the long œsophagus is particularly agitating, throwing itself from one side to another inside the neck, bending itself so violently as to remind one of the coiling of a rope when being shipped on deck."

The insect was now thoroughly hard at work, and this was therefore the opportunity for the next stage in the proceedings. In order to prevent the retraction of the proboscis, which would have followed the withdrawal of the insect, the experimenter determined to decapitate it suddenly, hoping that thereby the proboscis might remain extended. The forepart of the insect was therefore rapidly severed with a pair of fine scissors without previously disturbing it in its feast. The decapitated head, having been left as it was for a short time, was then gently raised with forceps, and the proboscis gradually withdrawn; the whole was then transferred to a slip of glass, and placed under the microscope without pressure. The appearance presented was such as is shown in the accompanying diagram (Fig. 111). A long fleshy tube was depending from the mouth; at its base was a stouter part, furnished at its apex with

a number of hooks, but the rest of the tube was thin, flexible, and transparent. Within the latter could be traced four thin chitinous bands, the representatives of the two pairs of jaws, the mandibles and maxillæ of the ordinary insect's mouth. Thus we have an arrangement resembling in some degree that of the mouth of the bed-bug and other Hemiptera, a tubular labium containing four setæ, the mandibles and maxillæ. During the process of the extrusion of this apparatus, the first part to appear is the strong base of the tubular labium, but the hooks are at first inside the tube. They can, however, be everted, and by a continuance of the same process, the membranous lining of the tube is brought out and forms the long delicate sucker which constitutes the greater part of the proboscis. The labium having been inserted into the skin, say through a sweat pore, the hooks become everted and hold the proboscis steady by clinging to the tissues around. The piercing mandibles are then thrust out; towards their tip they are

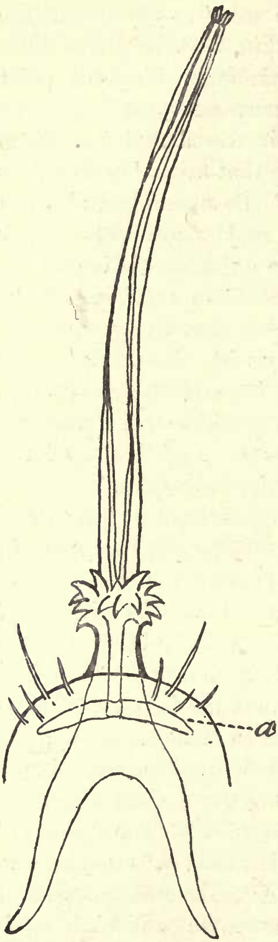


FIG. 111.—Proboscis of Body-Louse. (After Schiödte.)

united into a tube from within which the second pair of setæ is protruded, similarly united, and terminating in four small lobes, which seem to act as feelers. All this mechanism can be thrust out to varying distances, and hence the length of the exserted proboscis can be accommodated to the thickness of the skin of the victim in the particular place in which the animal is feeding; by this means the capillaries of the host are at length reached, when blood will at once ascend the proboscis, the flow being accelerated and continued by the vigorous action of the pump-like cavity in the digestive tube already mentioned.

But to return to our decapitated head. The observer, wishing to examine the structure of the proboscis under a higher power of the microscope, put it under pressure for that purpose, when instantly the whole apparatus shot back into the head, and no further observations could be conducted; in this position the two sides of a chitinous band, marked *a* in the diagram, look something like biting jaws, and had been mistaken for such by those who had not seen the protruded instrument. These appear as a dark band across the under surface of the head in Fig. 110, which was drawn from a specimen prepared for the microscope, and therefore more transparent than usual, and beneath them the outlines of the retracted proboscis can be traced. Schiödte had to carry out many other observations on specimens prepared in a variety of ways before the whole of the details enumerated above could be determined; and whoever wishes to verify these results, must be prepared to exercise great patience in the investigation. Leeuwenhoek was so much struck with the beauty and delicacy of this feeding apparatus, even so far as it was known in his time, that he appeals to its complex character as evidence that a creature which possesses so elaborate a sucking pump could not have been, as was

formerly believed to be the case, spontaneously generated from "dirt, sweat, or excrements," but must have an origin similar to that of more highly organised animals.

The sexes of *Pediculus capitis* differ considerably in size; the female is about one-eighth of an inch long, but her partner is sometimes not more than half that length, and is proportionately much narrower. They may be distinguished also by the shape of the terminal segment of the body, which in the female, as shown in Fig. 110, is notched, but in the male is evenly rounded. A large sharp-pointed organ, which may often be seen protruding from the end of the male's body, was formerly taken for a sting, and was supposed to be one of the causes of the itching produced by the insect. This, however, was a mistake, no such organ as a sting being possessed by these creatures: the instrument in question is part of the reproductive apparatus. The eggs, generally called "nits," are conical, or rather pear-shaped bodies, which are attached to the hairs of the host, especially near their roots. The secretion with which they are moistened when laid is formed into a sort of long cylindrical collar, which clasps the hair towards the lower and smaller end of the egg, holding it up like a bracket (Fig. 112). The eggs hatch after a little more than a week, the young making their exit from the broader end. The young are quite similar in form to the adult, for the insect passes through no metamorphosis whatever, being thus in a more generalised condition than any other we have described, except the "sugar-fish." Like other insects, they

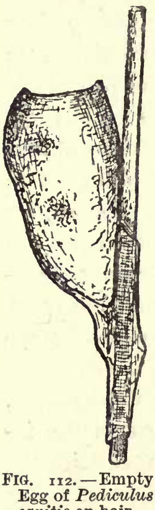


FIG. 112.—Empty Egg of *Pediculus capitis* on hair.

cast their skin several times as they increase in size, and ultimately mature their reproductive organs, but no other change ensues. The young *Pediculus* becomes full-grown in about a month, and is active throughout life, and ever ready for blood-sucking. Thus man's three personal blood-sucking parasites exhibit three distinct types of development, the flea, passing through a complete metamorphosis—larva, quiescent pupa, and perfect insect; the bug, an incomplete metamorphosis, having an active pupa stage, and acquiring rudimentary wings; the louse, no metamorphosis at all, there being no resting stage, and not the faintest semblance of wings ever appearing.

Pediculi are extremely prolific creatures, producing large numbers of eggs, and, as we have seen, passing rapidly into the adult and procreative condition, so that generation succeeds generation with undesirable speed and detestable powers of multiplication. Exact experiments as to the degree of fecundity they exhibit it is obviously not easy to persuade any one to undertake; nevertheless, some naturalists have so far conquered their repugnance as to investigate the matter slightly. There has long been a popular saying, evidently begotten of despair at their excessive multiplication, that a louse can become a grandfather in twenty-four hours. This, as mentioned above, is a great exaggeration, and so thought Leeuwenhoek, who flourished about 200 years ago; he decided, therefore, to undertake a series of experiments in order to settle the point and to work out the life-history, if possible. The species he experimented upon would appear to have been *P. vestimenti*, the body-louse, but the conclusions would probably have been similar with either species. His first thought was to hire some poor child whom he might use as a host, the

method proposed being to put a clean stocking on the child's leg and to enclose two or three female lice in it, then to tie the stocking tight at the garter, and keep it in this condition without change for a week, and then to examine it and see to what extent multiplication had taken place. This method of conducting the experiment, however, seemed likely to be too uncertain and too little under his own control; not that he expected to find any difficulty in securing the services of a suitable host, but because interference with the progress of the experiment would be left so much in the child's power. On further consideration, therefore, he resolved to overcome his repugnance, and try the experiment on his own person, at the expense, as he observes, "of enduring for a short time in one leg what most poor people are obliged to suffer in their whole bodies during all their lives."

He therefore selected a fine black stocking, so that the insects might the more easily be seen, and enclosed in it two large female specimens, fastening the stocking tightly above the knee. After leaving it thus undisturbed for six days, he took it off and found one insect in the place where he had put it, and around it fifty eggs, and in another part of the stocking forty others, apparently laid by the other specimen, which, however, had escaped. Opening the body of the parent of fifty, he counted in it about fifty more, and as he adds, "who knows how many eggs it had laid before I put it in the stocking, and how many more it might then have in its body which my sight could not reach?" Having worn the stocking for another ten days, he found in it about twenty-five crawling creatures of different sizes, the largest being apparently some three days old; but the sight of such a progeny caused even his endurance to reach its limit, and he was so disgusted that he

tossed the stocking and its contents into the street, and would have no more to do with it. On this slender evidence he based calculations by which he arrived at the conclusion that, though the fecundity of these insects was not nearly so great as the popular saying implied, yet that it was quite great enough to excite astonishment and alarm—that, in fact, a single female might in the course of eight weeks become a grandmother, and witness the birth of some 5000 descendants. Even if large deductions were made from this, yet powers of multiplication would still be left which show how unsafe it would be to let even a single specimen pass unheeded.

The head louse is usually found amongst the hairs of the head, but it may occur on other parts of the body as well. According to Andrew Murray, its general appearance varies with the nationality of its host, the colour especially being considerably different when it is found on dark-skinned races; *e.g.*, on West Africans and Australians it is nearly black, on Hindoos dark and smoky, on Hottentots orange, on the Indians of South America dark brown, while on the Chinese and Japanese it is said to be yellowish. An attempt has been made, though without success, to show that these forms are distinct species. Amongst some uncivilised tribes these insects are actually eaten, and apparently with relish. The mother, innocent of thoughts of a comb, relieves her child by hand-picking, and transfers her captures to her mouth, apparently as an easy way of disposing of them, thus imitating a habit which may also be seen in monkeys. In his "Primitive Folk," Reclus says that the Apache Indians, "when they have leisure to attend to their comfort, cover their heads, like the Australians and Andamanese, with a mud cap. This is agreeably cool, and rids them of vermin. For

Y

like reasons they coat their bodies with a layer of mud." The Esquimaux are said to make use of a little stick ending like a spatula, to scratch themselves; with it they can more easily reach their backs and dive into the depths of their clothing.

Many remedies have been proposed against these vermin, but to secure immunity from their attacks it should always be borne in mind that the prime requisite, which is the foundation of everything else, is cleanliness. For although there is no truth in the old idea of their being spontaneously generated from dirt, yet uncleanly conditions seem to constitute a peculiarly favourable environment for the introduction and propagation of the species. Frequent head-washing, therefore, especially in the case of children, is of the utmost importance, and yet it is surprising what an antipathy many people have to letting water come in contact with their head; it would seem that this is one of the last parts of his body, which, in the advance of civilisation, man is prepared to submit to the action of soap and water, though, as being exposed to all sorts of begriming influences, it certainly is not the part which needs it least. The habit of using oil, pomatum, and other greasy compounds on the hair, now happily declining, though objectionable for other reasons, had its uses, and was advantageous as a preventive against these parasites, since oily matters tend to clog up their spiracles and so suffocate them. Horrible mixtures were formerly recommended as means of extermination, *e.g.*, Mouffet advises a compound made of hogs' blood mixed with wine and essence of roses. The only true preventives are personal cleanliness and isolation, or avoidance of contact with those on whom the insects are found. For curative purposes, a wash made by boiling cheap tobacco in water has been recommended,

as well as rubbing snuff into the roots of the hair; but for such purposes nothing better can be used than very weak solutions of petroleum or carbolic acid. Frequent washing with carbolic soap is also a good thing in this, as in other afflictions connected with the skin. By those who do not object to the use of mercury compounds, an ointment made of "white precipitate" mixed with lard has been found efficacious.

Whilst *P. capitis* is usually confined to the head, *P. vestimenti*, the body louse, is found on the body at large, and, as its scientific name imports, is closely connected with clothing. It is rather larger than *P. capitis*, and as it is found on those parts of the body that are comparatively devoid of hair, it takes advantage of the seams and folds of the inner garments to deposit its eggs upon. Its chances of flourishing, therefore, depend mainly upon the clothing remaining unchanged for a long time; hence, in long marches, or on other occasions when few opportunities can be obtained for washing or changing clothes, it may become troublesome. It has often been an army pest during long campaigns. When Leeuwenhoek showed some of his specimens to "a certain great personage," the latter exclaimed that they were just like those with which his soldiers were infested, and stated that the men found them much more troublesome in wet weather than in dry. In the Crimean war, it is said that the soldiers were much annoyed by these horrible creatures, finding them far more of a nuisance than *P. capitis*. Their attacks produce an intolerable itching of the skin, often accompanied with inflammation. Of course warm baths and a thorough cleansing of the clothing are the chief remedies.

The crab louse (Fig. 113) is a very different creature from either of those we have been considering, and is

probably the most disgusting and hated of all the parasites to which mankind is subject. The thorax is much broader than in the other two species, and is even wider than the abdomen itself. This great and sudden width of the thorax, combined with the shortness of the abdomen and the lateral expansion of the legs, give it a crab-like shape, which is the origin of its popular name. The two hind pair of legs are much stouter than the front pair, and their claws are very strong, and curved completely back upon the foot, giving it an intense

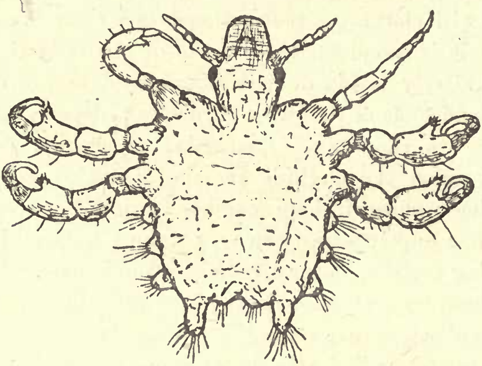


FIG. 113.—Crab Louse (*Phthirius inguinalis*).

clinging power. It ranges from $\frac{1}{20}$ to $\frac{1}{10}$ inch in length, and its life-history is similar to that of the rest, though it appears to multiply rather more rapidly, and to be communicated rather more freely. As its scientific name implies, it is an inhabitant chiefly of the groin, though when it exists in swarms, as is sometimes the case, it may be found on other parts of the body as well, such as the breast, the arm-pits, the beard, the eyebrows, and even the eyelashes. A frightful degree of multiplication of this insect, or of *P. vestimenti*, is either the

cause or the accompaniment of the mysterious diseases called *pediculosis* and *phthiriasis*, which have become so celebrated through their reputed connection with some of the vilest of historical personages.

A word or two on the systematic position and classification of these vermin may fittingly conclude our subject: this is the more necessary as there are several other insects that might easily be confounded with them. Pediculi are now regarded as forming a degraded section of the order Hemiptera, which, as we have already seen, contains the various species of bugs, &c. The nearest approach to the peculiar structure of the mouth in the Pediculi is certainly to be found in this order, the lice differing from the rest chiefly in having the suctorial trunk retractile, and capable of being completely withdrawn inside the head. The lice thus bear much the same relation to the rest of the Hemiptera that the fleas do to the Diptera (two-winged flies) with which they are now associated. The section of the order to which they belong is called Anoplura; but this term is often made to include another set of parasites externally something like them, but furnished with biting jaws instead of a suctorial proboscis. These are the insects called Mallophaga, or bird-lice, which devour the feathers of birds. But here again we must guard against being misunderstood. It is not implied that all parasites found on birds are true Mallophaga, nor that the latter are exclusively confined to birds. As a matter of fact, birds are troubled not only with the feather-eating Mallophaga, but with true lice allied to the Pediculi above mentioned, which suck their blood, just as the latter do that of mammals. These, of course, belong to the same section as the vermin whose life-history and habits we have been considering. The Mallophaga, however, being biting,

not sucking insects, seem to find their nearest relatives in the order Neuroptera, to which, in the previous chapter, we referred the little book-louse. Some of these Mallophaga also occur on mammals, whose hair they devour, just as those that infest birds make havoc upon their feathers.

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